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PUBLISHED QUARTERLY BY THE AMERICAN GEOGRAPHICAL SOCIETY
BROADWAY AT 156TH STREET, NEW YORK, N. Y.

Price, $1.25 a number Five dollars a year

Entered as second-class matter, January 22, 1916, at the Post Office at New York, N. Y., under the Act of August 24, 1912

Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on July 30, 1918

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THE
GEOGRAPHICAL REVIEW

VOL. XXV APRIL, 1935 NO. 2

GEOGRAPHY AND NATIONAL LAND PLANNING

W. L. G. Joerg

[With separate map, Pl. II, facing p. 204]

It cannot be too strongly stated that we do not approach the planning of natural and other American resources in any spirit of defeatism. The present emergency may have hastened the growth of systematic planning, but the careful inventory and appraisal of our resources, and the consideration of how we may most effectively utilize these resources, could not in any case have been long delayed, after our frontier had been closed and the progress of mechanical invention established as a permanent factor in our civilization.

We do not stand at the broken end of a worn-out road, but look forward down a broad way to another era of American opportunity. Among the nations of the world, America has stood and still stands for discovery, for pioneering across a great continent, for fearless experiment in directions where others had failed, for achievement in mechanism and management, for ready adaptation to new conditions and easy adjustment to new ways of life.

THUS concludes the report on national planning just published by the National Resources Board after being submitted to President Roosevelt on December 1, 1934. It is in this spirit that answers have been sought to questions relating to our national welfare by a number of recently created agencies, both within and without the Government.

The Science Advisory Board, created to advise the Government in questions of science, in its recent report on land use points out that the problems relating to land are regional and that their consideration and solution call for the regional approach.

The most immediate task is to diagnose and locate the ills of our land situation. Land crisis is not a late or temporary event. Farm abandonment in the Northeast has been progressive and in some areas has continued for a century. The destruction of land by erosion in the South has a background which extends to the abandonment of plantations in the Civil War. Overgrazing in the semiarid lands began to make itself felt disastrously in the nineties. The cut-over wastes of the Great Lakes commenced to blot out communities at the same time. The wheat and cotton gamble of the Great Plains dates principally from the time of the World War. The slowing

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down of our population growth was under way for years before its true nature became known in the past half dozen years. The effects of all these have continued, extended and become increasingly felt in the late years of general economic crisis. Our land ills are complex—there are quite different loci of production crisis, taxation crisis, social crisis and land destruction. Each problem is regional, and requires exact and competent field study and always translation of quantitative data into precise maps. Science and practice equally demand this exact analysis and localization of evidence. Beyond this immediate objective lies the planning of the future of our land, not as a political phantasy, but by applying the knowledge we may gain to the reduction and elimination of needless waste of life, wealth and cultural potentialities inherent in the old, cruel method of trial and error.

The reports that these two leading agencies have just published and the findings laid down therein form the theme of the present article. For a proper understanding of the reports it is desirable to know something of the antecedents and development of the two organizations. This information is given in the Appendix.

The Science Advisory Board's report on land use[1] bears the main title "Land Resource and Land Use in Relation to Public Policy." It was written by Dr. Carl O. Sauer, professor of geography at the University of California, who, at the invitation of the Board, came east in February, 1934, for three months and prepared the report at the American Geographical Society's building. It deals with the whole range of questions coming into consideration, with special emphasis on their natural-science basis, and constitutes a research program for the study of land use in the United States. The report is divided into three parts: I, Land Resource; II, Land Use; III, Land, The Geographic Totality. The main topics discussed under each of these three headings are: I, mapping the land, surface and soil, climate, native vegetation, surface water and ground water, mineral resource; II, population distribution and movement, land ownership, farm economy, commerce and industry, town and city; III, the geographic method, regional synthesis.

The National Resources Board's report[2] bears the subtitle "A

[1] Preliminary Report to the Land-Use Committee [of the Science Advisory Board] on Land Resource and Land Use in Relation to Public Policy, by Carl O. Sauer . . . , edited and supplied with bibliographical notes by W. L. G. Joerg . . . , Washington, April 26, 1934. This report (pp. 165–260) together with "Preliminary Recommendations of the Land-Use Committee Relating to Soil Erosion and Critical Land Margins, by Carl O. Sauer, C. K. Leith, J. C. Merriam, Isaiah Bowman, Chairman" (pp. 137–161) constitute Appendix 8 of the "Report of the Science Advisory Board, July 31, 1933 to September 1, 1934," 290 pp., Washington, September 20, 1934. The larger report deals with a wide variety of topics reflecting the activities of the Board. In addition to the section on land use the reports on the Weather Bureau (Appendix 1), on a proposed bureau of mineral economics and statistics (Appendix 5), and on the U. S. Geological Survey (Appendix 6) are of special interest to geographers.

[2] National Resources Board: A Report on National Planning and Public Works in Relation to Natural Resources and Including Land Use and Water Resources, With Findings and Recommendations. Submitted to the President in Accordance with Executive Order No. 6777 [of] June 30, 1934. Washington, December 1, 1934. The report is subdivided as follows: Foreword etc. to whole report, pp. i–vii, Part I (Report of the National Resources Board), pp. 1–88; Part II (Report of the Land Planning Committee), pp. 89–251; Part III (Report of the Water Planning Committee), pp. 253–388; Part IV (Report of the Planning Committee for Mineral Policy), pp. 389–449; Part V (Report of the Board of Surveys and Maps), pp. 451–455.

Report on National Planning and Public Works in Relation to Natural Resources." It represents a condensation by the staff of the Board under direction of Charles W. Eliot 2nd, executive officer, of reports prepared in five months by many collaborators within and without the Government. In vision and scope it is a worthy successor to the report of the National Conservation Commission in 1909,[3] which represents the first major evidence of our national awakening to the dangers of resource wastage and abuse. Like its predecessor it ranges over the whole field of the country's natural resources and supplies the primary material on which any presentation of the economic geography of the United States must in the future be based.

The National Resources Board's report is issued in five separate parts of varying length. Part I contains the Board's own report, with its findings and recommendations, together with a digest of Parts II-V and sections on public-works planning, state and regional planning, and "a plan for planning." Parts II to V deal respectively with land, water, minerals (constituting the reports of the three corresponding committees referred to in the Appendix), and topographic mapping. Part III, although dealing with the water resources of the whole country, is a corollary report to that of the Mississippi Valley Committee,[4] which became the Water Planning Committee of the National Resources Board (see Appendix). Another related report is the final report of the National Planning Board,[5] of which organization the National Resources Board is the outgrowth (see Appendix).[6]

Research Advocated by the Science Advisory Board

As stated above, the tenor of the Science Advisory Board's report is that of a program of research. Although it deals with the whole range of land use, there are a number of problems on the discussion of which special emphasis is laid. It is possible to select for presentation here two of the most important only—climatic risks and the surface and slope method of soil research—and these will have to suffice as

[3] Report of the National Conservation Commission, *U. S. 60th Congr., 2nd Sess., Senate Doc. 676*, 3 vols., Washington, 1909. Vol. 1 (276 pp.) contains the summarized findings and recommendations as to mineral, land, forest, and water resources. These are based on the reports of the contributing specialists published in Vols. 2 (771 pp.) and 3 (793 pp.).

[4] Report of the Mississippi Valley Committee of the Public Works Administration, Submitted October 1, 1934, to Harold L. Ickes, administrator, Federal Emergency Administration of Public Works, 234 pp., with numerous insert maps and diagrams, Washington, 1934.

[5] National Planning Board, Federal Emergency Administration of Public Works, Harold L. Ickes, Administrator: Final Report, 1933–34, vii and 119 pp., Washington, 1934. This is a printed report. It was preceded by a series of mimeographed statements and reports entitled "Circular Letters" which ran at least to eleven issues, a number of which contain material of informational and bibliographic value, e.g. No. 2: list of references on regional planning, No. 11: list of regional planning agencies.

[6] The reports referred to in footnotes 1, 2, 4, 5, will be cited in this article by the respective abbreviations SAB, NRB, MVC, NPB.

The present discussion quotes freely from the texts of the reports: it has not, however, proved practicable to distinguish quoted matter in all instances, but the page references cited in connection with each topic indicate specific sources and serve as acknowledgments.

examples of the whole inquiry undertaken by the Board. The soil research method has direct bearing on the urgent problem of soil erosion, to which some attention will therefore also be devoted. In addition reference will be made to the classification of land according to soil productivity that has been carried out by the Soil Survey Division of the Bureau of Chemistry and Soils.

Climatic Risks[7]

No single element of the environment is so uncertain, and hence so difficult to fix, as is climate. Not a concrete object, such as the rocky substructure, the soil mantle, or the vegetation cover of the earth's surface, of each of which the distribution and characteristics can be established by examination *in situ*, climate, like time, is an abstraction. Representing the cumulative effect on a given locality of the daily procession of atmospheric conditions throughout the years, with their seasonal and secular variations, it can only be captured conceptually by analyzing long-time weather records and determining the characteristic pattern of their curve for any given area. Variability, however, is the keynote of climate; it is the factor that imparts the quality of uncertainty to this aspect of natural environment. To determine the fluctuation range of variability is hence to make a major advance in our knowledge of this basic factor in man's environment.

In the determination of fluctuation range a fruitful method is provided by R. J. Russell's concept of expansion and contraction of climatic areas.[8] According to this view climate represents the meteorological conditions within a nuclear area that expands and contracts irregularly. In other words, a climatic area is not an area with fixed limits but an area whose borders are constantly shifting back and forth. These zones of fluctuating climatic limits are of the greatest practical importance. They are immediately reflected in frequency and extent of crop failure and of shortage of pasture.

There are several such zones of hazard in field agriculture and grazing. Widest and most significant are the fluctuating borders between humid and semiarid lands, between desert and steppe. A special subordinate form of drought risk zone is found in that part of the Southwest where the rainy season normally begins late, as in June or July, and where an exceptional delay of the rainy season reduces the effective growing period so that crops and grass do not mature, though

[7] SAB, pp. 199–203, 144, 149, 153–154.

The term "risk maps" as applied to climate was suggested by Isaiah Bowman in "Applied Geography," *The Scientific Monthly*, Vol. 38, 1934, pp. 173–177.

[8] In developing the concept Russell (Dry Climates of the United States, II: Frequency of Dry and Desert Years, 1901–20, *Univ. of California Publs. in Geogr.*, Vol. 5, No. 5, 1932) first applied it to the western United States. He later extended it to the whole country (Climatic Years, *Geogr. Rev.*, Vol. 24, 1934, pp. 92–103). Recently H. M. Kendall (*Geogr. Rev.*, Vol. 25, 1935, pp. 117–134) has investigated the oscillation of the climatic boundaries east of the Rocky Mountains year by year from 1914 to 1931.

total precipitation and average temperature may not be far from normal. Another variant is introduced into the dry and subhumid climates by abnormal diminution of the snow blanket, as by chinook weather. At the other end of the climatic series lie fluctuating zones of excessive moisture, and still in another direction areas of hazard of summer frosts. The largest zone of climatic risk is of course in the Great Plains,[9] which is also the area of greatest expansion of American agriculture in the past decades. Other similar areas are found west thereof as far as the Coast Ranges. Frost hazards in the growing season are especially characteristic of parts of the upper Great Lakes states, there usually conditioned by ineffective air drainage of low-lying tracts. Serious abnormalities of excess moisture are most frequently encountered in the southeastern coastal plain.

This question of climatic risks, i.e. risks of agriculture due to climatic variability, which has been stressed by the American Geographical Society in the various pioneer settlement studies undertaken or sponsored by the Society[10] and whose importance was emphasized also by the Science Advisory Board in its report of April 26, 1934, and its land-use conference of June 14 of that year, is given wide consideration in the National Resources Board's report of December 1, 1934.[11]

Two newly compiled maps, one of average percentual deviation from mean annual rainfall (in 1 : 12,000,000, facing p. 294) and the other of degree of frequency of subnormal precipitation during the growing season (p. 248; reproduced herewith as Fig. 1), deal with rainfall variability. Fluctuation in precipitation is also illustrated by a cartogram and diagarms of "moving averages" at typical stations.[12] These maps and graphs show a number of things.

In the humid East and South and in the humid Pacific Northwest the average deviation is low, and droughts are infrequent. Deviation and droughts increase rapidly west of the Mississippi; droughts are especially serious in the Great Plains, the intermountain area, and the Southwest. In general the widest deviations occur where such variations are most serious, namely in the arid and semiarid regions. Whereas New England, with an average annual precipitation[13] of 45 inches and an even chance of not more than 10 per cent deviation in any one year, would still receive 41.5 inches, which is reasonably ade-

[9] In a fresh analysis of the broad aspects of climatic fluctuation in the United States Isaiah Bowman (Our Expanding and Contracting 'Desert', *Geogr. Rev.*, Vol. 25, 1935, pp. 43–61 and map on p. 58) shows how the Great Plains straddle the transitional belt in which lie the boundaries expressing various forms of change from wet to dry climates.

[10] Isaiah Bowman: Pioneer Fringe, *Amer. Geogr. Soc. Spec. Publ. No. 13*, 1931; Pioneer Settlement, *ibid.*, *No. 14*, 1932; W. A. Mackintosh: Prairie Settlement: The Geographical Setting (Canadian Frontiers of Settlement, Vol. 1), Toronto, 1934.

[11] NRB, pp. 77, 162, 248–249, 298–299, 320–324; also MVC, pp. 109–111.

[12] NRB, p. 299 and facing p. 296; also MVC, p. 103; partial equivalent in *Geogr. Rev.*, Vol. 25, 1935, p. 51.

[13] Map showing distribution of average annual precipitation in the United States, 1 : 12,000,000, NRB, facing p. 292; also shown in form of "block diagram" map, *ibid.*, facing p. 298.

quate, the situation in Imperial Valley, California, with an equal probability of 40 to 50 per cent deviation from an annual rainfall of 5 inches or less, which means 2½ to 3 inches in the driest years, is fraught with great risks to agriculture and increases the strain on the procurement of water from sources other than the local rainfall.

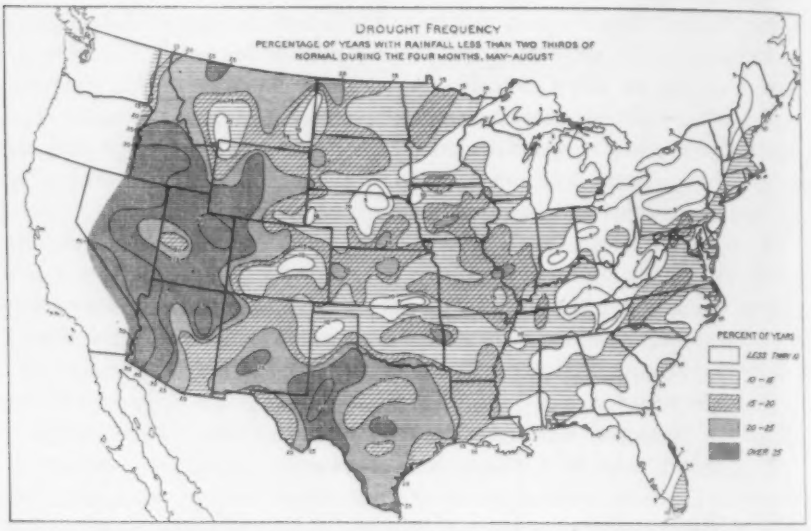

DROUGHT FREQUENCY
PERCENTAGE OF YEARS WITH RAINFALL LESS THAN TWO THIRDS OF NORMAL DURING THE FOUR MONTHS, MAY-AUGUST
PERCENT OF YEARS

FIG. 1—Degree of frequency of subnormal precipitation (two-thirds of normal) in the United States during the growing season for crops (May to August inclusive). (Fig. 67, NRB, p. 248.)

THE DROUGHT OF 1934

The dry periods which occurred in most parts of the United States with extreme severity during the years 1930–1934 have emphasized anew the reality of climatic variability. Such droughts are caused by prolonged deficiencies in normal rainfall, often extending over several years, so that the cumulative effect of lowered ground-water levels is superimposed upon seasonal rainfall inadequacy. Whereas great floods are often, perhaps usually, relatively local phenomena,

> great droughts always have a large regional aspect, being affected by major (though temporary) changes in the atmospheric circulation over wide areas of land and sea. Floods occur, produce damage, and are quickly gone. They may always be controlled by man if there is sufficient justification for the expenditure involved. Droughts come on insidiously, last a long time, and may affect agriculture and other human activities for years after normal rainfall returns. . . .
>
> During the spring of 1934 precipitation in areas west of the Mississippi River fell far below normal in consequence of the stagnation of a relatively hot air mass over the interior. Figure 1b [the present Fig. 2] shows that by August the percentage of normal accumulated precipitation was as little as 50 per cent and even 40 per cent over large portions of the Midwestern and Western States. This deficiency, in combination with excessively high temperatures, caused the drying up of grasslands and crops, the lowering of shallow ground water levels, and the reduction of stream flows.

The shortage of soil moisture and the diminution of stream flow was especially serious because the snowfall of the previous winter had been meager, and because in some areas, such as the eastern Dakotas, precipitation had been deficient during the four preceding years. Drought so severe that some . . . had thought it would not be duplicated for scores of years had occurred in most of the East-Central States during 1930–31, and . . . full recovery had not taken place in every area when the 1934

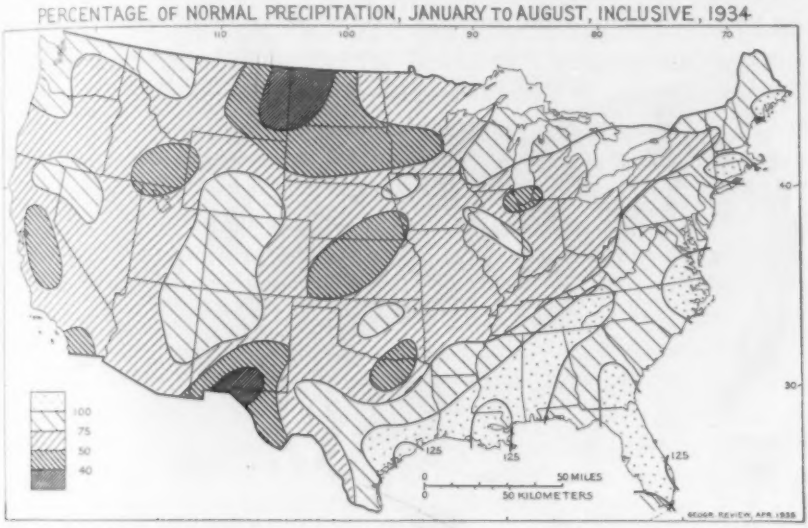


FIG. 2—Deficiency of precipitation, January to August, 1934, inclusive (except areas over 100 per cent) to illustrate the drought of 1934. (Redrawn from Fig. 1b, NRB, p. 320.)

drought set in. The deficiencies in ground water particularly had in many areas not been replenished since 1930, and, rainfall deficiencies continuing, the recent drought was the result of cumulative conditions which had been in progress for several years. In semiarid and subhumid regions the continued negative departures from a normally meager precipitation meant that there was not sufficient rainfall even to supply moisture to the topsoil, let alone enough to replenish the ground-water supplies, and this accounted in part for the widespread dust storms which in May dramatically carried the story of the great drought to eastern cities.[14]

The unpredictability of such "calamities of nature" is in part illustrated by comparing Figure 2 with Figure 1. The areas of severest drought in the Dakotas in 1934 correspond with areas of relatively low frequency percentage on Figure 1, and even the dry areas in Kansas and southwestern Oklahoma do not match well, although the area in southern New Mexico has a close counterpart on the frequency map. But close correlation should not necessarily be expected, as low frequency percentage does allow severe occurrence in the years when drought *does* occur. The correspondence between Figure 2 and the map of precipitation deviation (NRB, facing p. 294) is, as might be expected, much closer. This is especially true of eastern Montana, Kansas, and southern New Mexico.

[14] NRB, pp. 320–321.

Soil Erosion

The most important physical crisis in land use is soil erosion,[15] a term used to include various wastages in land surface as a result of human exploitation. The gravity of the soil erosion problem in the United States is apparent from the estimates that have been made of its extent (Fig. 3). At least 35,000,000 acres of formerly valuable

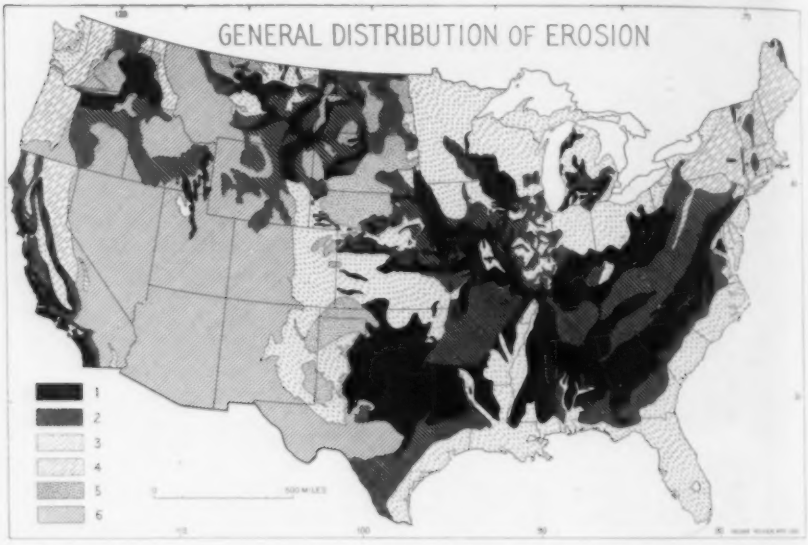


Fig. 3—Degree of soil erosion. The maximum erosion by water, in the form of sheet erosion and gullying, has taken place in areas 1 and 2, where respectively serious and harmful erosion is widespread over cultivated and overgrazed areas. In area 6, mainly the intermountain West, there is in general much serious erosion owing to overgrazing chiefly. In area 3, the relatively flat lands, and in 4, the hilly and mountainous country of the Northeast and the Pacific Northwest, erosion is generally not serious, though it is bad locally in area 3. Area 5, in the Great Plains and the Columbia Plateau, is characterized by wind erosion, much of it serious where the soil is cultivated. (Redrawn from standard map by Soil Erosion Service, 2nd edit., 1934; also in MVC, facing p. 62.)

cultivated land already have been essentially ruined in so far as further practical crop use is concerned; and 125,000,000 additional acres, most of them still in cultivation, have been largely stripped of the productive topsoil, with a resultant decline in productivity ranging up to 90 per cent. At least 100,000,000 acres of our remaining valuable agricultural lands are heading rapidly in the same direction and thus are being transformed into marginal and submarginal land. In other words 9 per cent of our 413,000,000 acres of cropland has been completely ruined, 30 per cent partially ruined, and 24 per cent (or about 14 per cent if the 379,000,000 acres of pasture be included) are potentially subject to destruction.[16]

Soil erosion had previously been a subject of investigation by the Bureau of Chemistry and Soils of the Department of Agriculture.

[15] NRB, pp. 161–174, 120–123, 62–66.

[16] A detailed table of amount of acreage in various stages of erosion is given in NRB, p. 171.

which, in coöperation with State Agricultural Experiment Stations, maintained ten erosion stations located in especially critical regions.[17] The Forest Service of the same Department also has carried on extensive research in regard to the part played by forests in erosion control. But the main impetus came with the establishment, in October, 1933, under the Department of the Interior, of the Soil Erosion Service to administer a grant of $5,000,000 for erosion work made by the Federal Emergency Administration for Public Works. An additional grant of $5,000,000 became available for expenditure in March, 1934. The Service has three principal functions: to investigate the process and causes of soil wastage, to record the areal extent and severity of surface destruction, and to undertake protective and restorative measures.

In carrying out its program the Soil Erosion Service has established projects in 24 areas throughout the country. Twenty of these, termed demonstration watershed projects, in areas ranging in size from 25,000 to 200,000 acres, involve reorganization of land-use practices and the installation of such measures as are needed to control erosion, conserve water, control floods, and place farming on a practical long-range yield basis. Two of the projects have been established on federally controlled land, one on the Navajo Indian Reservation with an area of 15,000,000 acres and the other on the Gila River watershed in Arizona and New Mexico with an area of 8,200,000 acres.

> The Navajo project is on lands which contribute vast quantities of silt to Boulder Dam and involves the preparation and application of comprehensive erosion-control, land-use and range-control measures. It also involves the reorientation of the entire agricultural-economic system of 45,000 Navajo Indians.[18]

In the carrying out of the watershed projects a comprehensive plan for the control of erosion and the reduction of floods and silting in the given area is worked out. This plan is based on the physical and chemical characteristics of the soil involved, the slopes, the climate, the vegetation, adaptable crops, and the agricultural practices of the areas, and applies all known methods of control, chosen for their particular adaptability to the particular situation. The control measures consist mainly in the building of check dams and in the introduction of strip cropping, terraces, and contour furrowing.

Surface and Slope Method of Soil Research

As a background for the control work of the Soil Erosion Service certain types of work are undertaken. In the formulation of the Service's plans for this research the Science Advisory Board suggested a fundamental investigation of the relation of soil to slope.[19] This

[17] See H. H. Bennett: The Quantitative Study of Erosion Technique and Some Preliminary Results, *Geogr. Rev.*, Vol. 23, 1933, pp. 423–432; reference on p. 423 and map, p. 424.

[18] Annual Report of the Secretary of the Interior for 1934, p. 358.

[19] SAB, pp. 179–190, 142–151.

suggestion was accepted and the method carried out in the Navajo Indian Reservation during the summer of 1934. The principle underlying the soil-slope study has been formulated by Dr. Sauer in the report of the Science Advisory Board as follows (pp. 180–183, *passim*):

> The same processes that shape soils are responsible for the surface that spans the soil. Both are produced through atmospheric agencies working, usually, through an intervening medium of vegetation upon materials of the earth's crust. Both are fashioned concomitantly by weathering, denudation, and deposition (all of which are climatically conditioned), modifying the outer part of the solid earth (expressed in kinds and attitudes of rocks).

Hence, the same methods are applicable as in geomorphology, or the study of land forms, and real advance in the science of soils is contingent upon the recognition that soil forms and surface forms are genetically two aspects of one development and that they are not fully intelligible except in terms of each other.

> The problem is, in its last essentials, that of the effect of climate and crustal stability or instability on the surface-soil complex, and thereby the old conceptual unity of the earth's surface is reasserted by the experience of soil students and geomorphologists alike. . . .
>
> The production of a well-developed soil under a given climatic condition, whether ecto- or endo-dynamic [i.e. conditioned by forces from above or derived from materials beneath], takes place only if weathering of undisturbed material continues for a considerable length of time. This results for the most part only if the soil forms on a surface of low slope or of none at all. The Russians were led readily to their recognition of soil horizons, since they were working in a land of great smooth plains.
>
> As soon as instability of the crust has been introduced, whether current or of recent date—a condition which characterizes most parts of the earth's surface—denudation and, in many cases, erosion are set up and relief is developed. Then soil does not accumulate beyond a certain limit and the material has only partial stability. As long as relief is increasing, the mobility of the slopes increases and the soil should be losing the characteristics of maturity, i.e. be undergoing retrograde development. With continued stability and therefore decreasing relief (at least after a time), the tendency will be for slopes to decrease gradually and soil horizons to develop farther. Where soils are associated with notable slopes, both are an expression of the mobility of the material, which is suffering seasonal or even continuous down-slope migration of its most finely weathered constituents, chiefly by insensible but cumulatively effective mass migration down grade.
>
> Under conditions, therefore, which are determined by climate, parent material and uplift, a balance is maintained between weathering and removal which is recorded in soil depth and constitution and in surface slope. The soil is then no longer to be considered as sedentary but as only in momentary equilibrium, containing particles from the entire slope above, intimately mingled. Every slope is continuously acquiring and almost continuously losing weathered material. It can acquire under a protective cover of vegetation only a certain maximum amount or depth; with diminution of surface cover, sluicing by running water is added to the forces of removal and the depth is diminished unless and until an adequate cover is restored.
>
> This most critical question, as to what happens on slopes, has received little exact attention. Yet, barring our smooth plains, it is the fundamental scientific problem of our land surface and one of the clearest illustrations that fundamental science and practical ends may be identical. A morphology inclusive of soil and surface must be

developed and must direct attention especially to the relationship of soil to slope. Until then the entire classification of soil is inadequate and the problem of soil erosion remains on an empirical basis.

Survey of Soil Productivity

In the Bureau of Chemistry and Soils a classification of the soils of the United States has been made under the direction of Dr. C. F. Marbut in which they are rated according to their agricultural productivity.[20] The work was carried on coöperatively with the Division of Land Economics of the Bureau of Agricultural Economics and the State Agricultural Colleges and Experiment Stations.

On the basis of the soil characteristics as obtained from the soil maps and reports published by the Bureau of Chemistry and Soils (for index map, see NRB, p. 250), the soils were grouped into productivity units or into units in which the soils have approximately uniform inherent productive capacity. The groups were then arranged in the order of their inherent productivity as determined from the consideration of the principal physical conditions influencing productivity, such as soil type, topographical relief, rainfall, and temperature. Each group was then rated by giving it an index figure designating its productivity for each of a series of crops. The crops selected were those that may be grown in the environment or those that are dominant. The index figure for the productivity of a given land type (usually a soil type) for any crop expresses the relative productivity of this type of land compared with that type having in the United States the highest productivity for the crop concerned. The land type best adapted to the crop is given a rating of 1 and the other lands are rated in proportion from 1 down to 5. Soils on which fertilizers are extensively employed are given a double rating. Grade 1 may be described as excellent land for the given crops; grade 2, as good; grade 3, as fair; grade 4, as poor; and grade 5, as essentially incapable of tillage.

With detailed soil surveys of about half the agricultural lands of the country and reconnaissance surveys bringing the total up to somewhat less than half of the whole country, any classification is necessarily tentative in character. The following figures covering the entire land surface of the United States (whether the land is in farms or not in farms) should hence be judged in the light of these limitations. Nevertheless, they afford the first available approximation of this sort.

PRODUCTIVITY CLASSIFICATION OF THE LANDS OF THE UNITED STATES

Excellent . .	101,000,000 acres	Poor	363,000,000 acres
Good	211,000,000 "	Essentially non-arable .	882,000,000 "
Fair	346,000,000 "		
		Total	1,903,000,000 acres

[20] National Land Use Planning Committee Publ. No. 5 (mimeographed), Washington, July, 1933, pp. 4–7; NRB, pp. 126–127.

An example of the maps embodying the results of this classification is afforded by the accompanying soil productivity map of New York State (Fig. 4).[21] The acreage in New York State of the five Federal grades are given as follows in a table in the National Resources Board report (p. 127) giving acreages of the five grades in all the states:

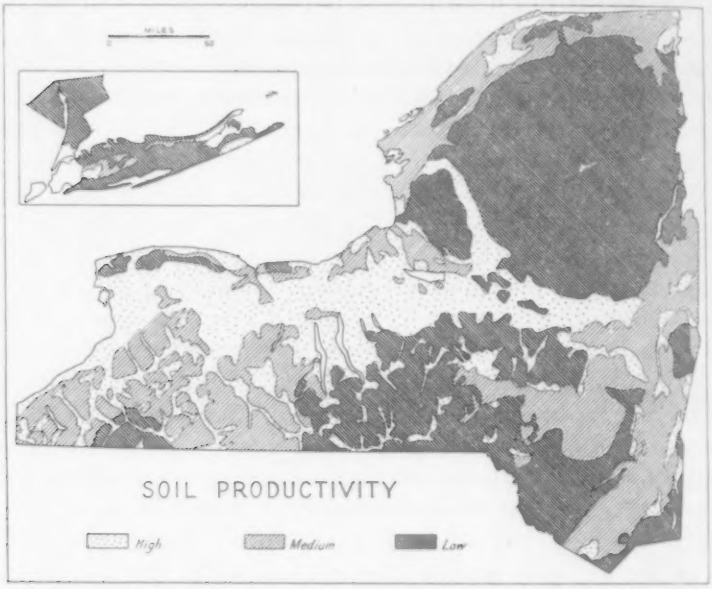


FIG. 4—Soil productivity in New York State, to illustrate the soil productivity survey of the United States undertaken by the Bureau of Chemistry and Soils, in coöperation with which agency this State survey was carried out by the New York State College of Agriculture. The three soil classes of the State classification apparently correspond to the following units of the Federal classification (see the text): high = excellent plus good; medium = fair; low = poor plus essentially non-arable. (From map, p. 27, of report cited in footnote 21.)

excellent, 94,000; good, 6,864,000; fair, 9,249,000; poor, 9,172,000; essentially non-arable 4,926,000.

Recommendations of the National Resources Board

So much for a number of the outstanding research topics in the field of land-use study, as they are discussed, in the main, in the Science Advisory Board's report. Let us turn now to the National Resources Board's report. It is organized, it will be remembered, according to the various natural and economic elements coming into consideration, and this review will on the whole follow that arrangement. First, however, what kind of land is dealt with, and in what amounts? The following table, generalized from one in the Board's report (p. 109), gives the answer:

[21] From "State Planning for New York: Summary Report of Progress", New York State Planning Board, Albany, January, 1935, p. 27.

TABLE I—CLASSIFICATION OF LAND AREA OF THE UNITED STATES ACCORDING TO ITS MAJOR USES, 1930

(*Total area = 1903 million acres*)

CLASS OF LAND	AREA IN MILLION ACRES	PER CENT TOTAL	CLASS OF LAND	AREA IN MILLION ACRES	PER CENT TOTAL
I. *Agricultural Land*			II. *Non-Agricultural Land*		
Crop land	413	22	Forest and woodland (grazed)	249	13
Pasture land	379	20	Forest and woodland (not grazed)	208	11
Woodland	150	8	Grazing land (not in forest or woodland)	329	17
All other land	45	2			
Total	987	52	Total	786	41
III. *Land of Non-Agricultural Non-Forest Use*			IV. *Lands of Little or No Use*		
Urban	12	0.7	Waste land occurring in:		
Parks (National, State, County), etc.	12	0.7	Public domain, Indian reservations, State lands, etc.	42	2.1
Roads	19	0.9	Railroad grant lands	5	0.3
Railroad rights-of-way	4	0.2	Rocks and barren land	20	1.0
Bird and game refuges	1	0.1	Swamps, tidal marshes, beaches and dunes (not used)	10	0.6
Swamps and tidal marshes used for hunting	5	0.3			
Total	53	3	Total	77	4

AGRICULTURAL LAND[22]

The Nation's requirements of agricultural products will be determined in the main by prospective population, standards of consumption, foreign trade, and probable changes in yields and carrying capacity.

Taking twenty-five years hence as a date to which estimates may reasonably be projected, the National Resources Board's report arrives at the conclusion[23] that, in view of the early prospect of a stationary population, the number of inhabitants in 1960 will be about 15,000,000 to 17,000,000 more than the present (1935) assumed population of 127,000,000. In this estimate the two possibilities of a cityward migration like that of 1920–1929 and of no such migration are envisaged (Fig. 5).

As to future domestic consumption, there appears to be little reason to anticipate a material modification in per capita requirements of crop land within the next twenty-five years. As the choice we and

[22] NRB, pp. 114–134, 156–202, 11–13, 15–20.
[23] NRB, pp. 92–97, 9–10.

other nations make with reference to foreign trade policy obviously will govern export requirements—and these decisions are unpredictable—no weight has been given to this factor. Nor does there seem likelihood of increase in crop yield and carrying capacity. While the experience of European countries suggests the theoretical possibility of a great increase in productivity of our arable land, it would be at great expense for the most part. The factors making for greater yields tend

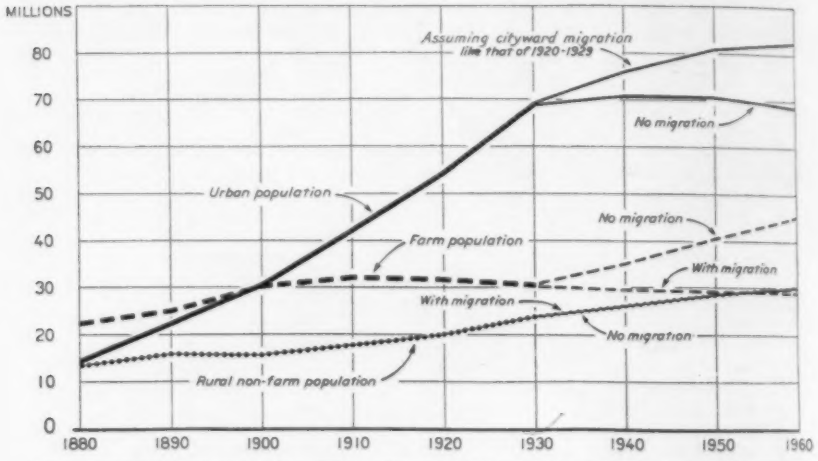


FIG. 5—Population of the United States, 1880–1960, differentiated as urban, farm, and rural non-farm population. The figures for 1880–1930 are from the Census (except those for 1880–1910 farm and rural non-farm population, which are estimated on the basis of the Census totals). The figures for 1940–1960 are the estimates of Thompson and Whelpton of the Scripps Foundation for Research in Population Problems. (Fig. 6, NRB, p. 96.)

to be offset by opposing factors, such as soil depletion and absence of population pressure.

Taking these various premises into account it appears[24] probable that we must provide an additional 30,000,000 acres of crop land to meet our requirements in 1960. Furthermore, as will be set forth immediately, about 25,000,000 acres should be retired from cultivation because of poor quality and to prevent further deterioration. As the land to be brought into use for crops will be of higher productivity than that proposed for retirement, these 25,000,000 retired acres may be considered equivalent to 17,000,000 acres of new cultivation. Thus we shall probably find it necessary to increase the amount of our arable land by 47,000,000 acres in the next twenty-five years. This can be amply covered from our reserves in the following estimated amounts: 3,000,000 acres of land irrigable within the range of feasible cost, 10,000,000 acres through the draining of wet lands, 10,000,000 acres of new clearing on the better quality of soils now in stumps or trees, and about 32,000,000 acres from plowable pasture.

[24] NRB, pp. 110–112, 128, 12.

Retirement of Submarginal Land[25]

It is proposed to retire some 25,000,000 acres of crop land. This total was arrived at as the result of a survey the land consultants in each of the forty-eight states were directed to make, township by township, in consultation with various sources of local agricultural information. A tabulation of the area within the townships which

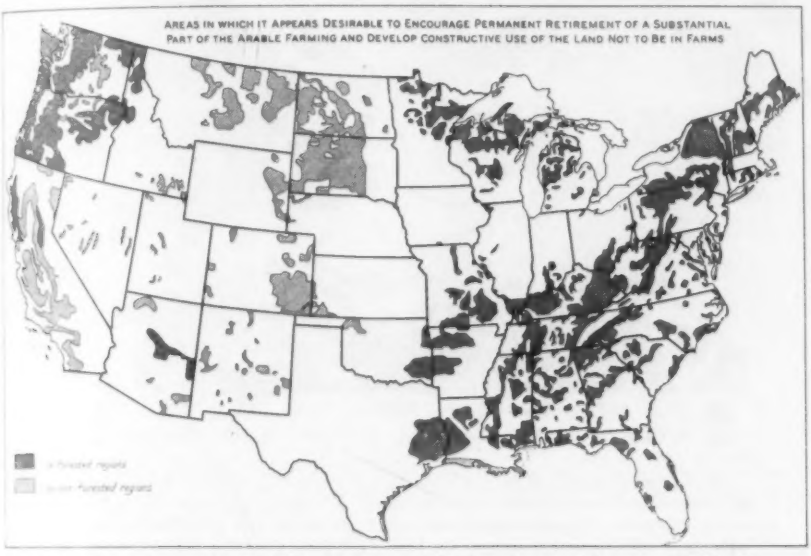

AREAS IN WHICH IT APPEARS DESIRABLE TO ENCOURAGE PERMANENT RETIREMENT OF A SUBSTANTIAL PART OF THE ARABLE FARMING AND DEVELOP CONSTRUCTIVE USE OF THE LAND NOT TO BE IN FARMS

FIG. 6—Submarginal land in the United States, as defined at the top of the map. Within the areas shown "experience has demonstrated the land to be too poor to provide adequate family living and support public institutions and services . . . Many of them are very sparsely settled and required public aid to help bear the high per capita expenditure for roads and schools. Most of them also have some land which should continue in agriculture. Further investigation will make possible a refinement of this map," which is a composite preliminary map prepared by the state land-planning consultants of the National Resources Board. (NRB, map on p. 16 and Fig. 44 on p. 176.)

the consensus of well-informed opinion adjudged economically and socially unsuited for continued cultivation showed a total of about 52,000,000 acres in crops. Of this amount about 20,000,000 acres are on the 454,000 farms it is proposed to retire from arable farming. The additional 5,000,000 acres it is proposed to retire are outside these farms and represent cropland it would be desirable to withdraw and convert into pasture in order to increase the size of farm units in certain areas. The 454,000 farms aggregate about 75,000,000 acres and include besides 35,000,000 acres of pasture land and 20,000,000 acres of forest and woodland, waste, and other land.[26] The total value of these farms is estimated to be $683,000,000. In general the areas in which these farms lie are found in hilly, forested country, the drier portions of the

[25] NRB, pp. 110–111, 127–128, 175–184, 15–20.

[26] The distribution of this threefold acreage and of the crops grown on the harvested acres, classified by the 16 "problem areas" into which the country has been divided (map, NRB, p. 156), is indicated in two tables in NRB, p. 181.

Great Plains, and regions of light sandy soil or serious erosion. All but a few of the areas are occupied by a sparse population so that the per capita cost for public services, such as schools and roads, is high. The location of these various areas is shown on Figure 6.

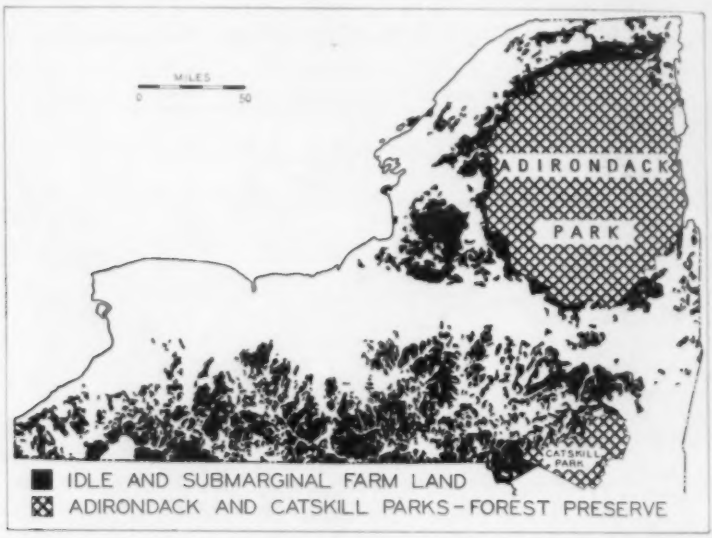


FIG. 7—Submarginal land in New York State, giving the details from which the representation of the State on Figure 6 was generalized. The reconnaissance land-classification survey from which this map resulted was carried out by the New York State College of Agriculture with the coöperation of the New York State Planning Board and the National Resources Board. Exclusive of the southeastern counties beginning with Sullivan, Ulster, and Columbia (which were not included in the survey because of the relatively high value of land which would exclude profitable use as forest land) and the Adirondack and Catskill Parks, the submarginal land amounts to 5,800,000 acres. (From map, p. 23, of report cited in footnote 21.)

FOREST LAND[27]

The total forest area of the United States is 615,000,000 acres. About 109,000,000 acres are classed as chiefly valuable for uses other than timber and include piñon-juniper forests, chaparral, alpine types, etc.; 11,000,000 acres are withdrawn from timber use in the form of parks and other reservations. This leaves 495,000,000 acres available for commercial use, i.e. land capable of producing timber of commercial quantity and quality (Fig. 8).

On the basis of trends in consumption and the average consumption for the years immediately preceding the depression the Forest Service estimates normal annual future drain at 16,500 million cubic feet. This happens to be roughly equivalent to the annual drain in the forest for the period 1925–1929. If the general outlook for a period of serious scarcity in timber should be realized, this might result in modi-

[27] NRB, pp. 135–143, 206–216, 13, 21–22.

fications in consumption standards, including the development and adoption of substitutes.

Timber growth under present conditions totals less than 9000 million cubic feet annually. This rate of growth would be entirely

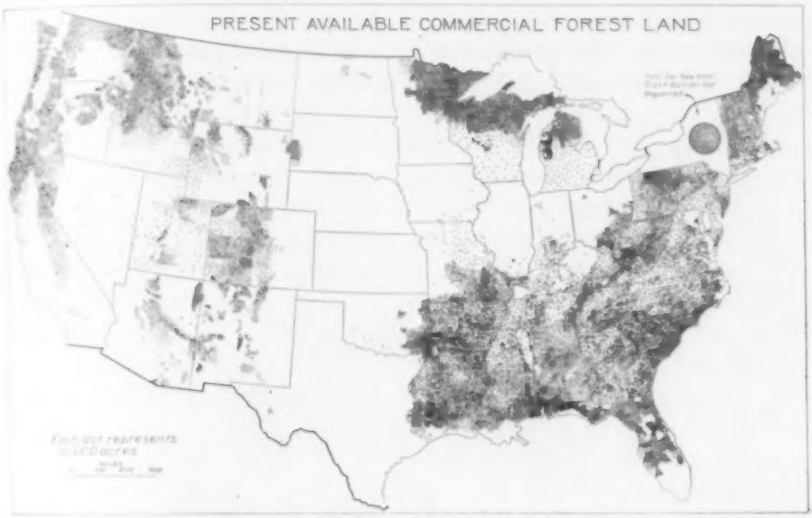


FIG. 8—Land supporting or available for and capable of producing forest products outside of farms and Indian reservations in the United States. Parks and other areas withdrawn from commercial use are excluded. (Fig. 30, NRB, p. 141.)

inadequate to supply the volume of consumption. The problem of balancing growth and drain, however, is a function not merely of area but also of management of the area. On the basis of a county by county survey, taking into consideration particularly the relationship of the forest to the life of local communities, the Forest Service has reached the conclusion that relatively large proportions of the forest area should be under intensive management and public ownership and administration (Table II).

TABLE II—ACREAGE RECOMMENDED BY FOREST SERVICE FOR VARIOUS KINDS OF MANAGEMENT, BY TYPE OF PROPOSED OWNERSHIP

(*In million acres*)

OWNERSHIP	TOTAL	INTENSIVE	EXTENSIVE	PROTECTIVE
Private	231.2	113.3	81.9	36.0
Federal	291.7	131.9	54.7	105.1
State	68.5	46.6	12.3	9.6
County	3.8	2.3	1.3	.2
Municipal	.9	.5	.1	.3
Total	596.1*	294.6	150.3	151.2

*19 million acres of specialized areas omitted.

These figures for 1960 imply an increase over 1934 in Federal ownership of 134,000,000 acres and in State, County, and municipal ownership of 50,000,000 acres and a decrease in private ownership of 204,000,000 acres.[28]

However, forest land should not be judged merely in terms of timber use. Forests are important for the part they play in the regulation of stream flow, the prevention of erosion, and protection from the wind. They provide a habitat for wild life and have large possibilities

FIG. 9—Forests of the United States differentiated according to their relative influence on watershed protection. (Fig. 1, p. 1511, in "A National Plan for American Forestry," *73rd Congr., 1st Sess., Senate Doc. No. 12*, 2 vols., Washington, 1933.)

for outdoor recreation, as well as being closely interrelated to agriculture. The influence of the forests of the United States on stream flow and erosion is regionally and quantitively evaluated on the accompanying map (Fig. 9) from the "National Plan for American Forestry" (Copeland Report).[29] Of the total wooded area of 615,000,000 acres the forest on 308,000,000 acres exerts a major influence, and on an additional 141,000,000 acres it exerts a moderate influence. The reforestation of probably 22,000,000 acres of abandoned crop and pasture land is considered necessary to prevent continued disastrous erosion. The forest land on which forests should exert an important influence in the conservation of water and the prevention of erosion may therefore be placed at about 571,000,000 acres. Of this, 11,000,000 acres is non-restocking forest land in need of replanting.

[28] Two text maps in the NRB report (pp. 210–211) show distribution of present and recommended ownership of forest lands.

[29] For a discussion of the report see Henry S. Graves: A National Plan for American Forestry. *Geogr. Rev.*, Vol. 24, 1934, pp. 129–133.

Range Land[30]

The 884,000,000 acres of range land are made up of 550,000,000 acres of nonforest ranges, chiefly west of the 100th meridian, and 334,000,000 acres of forest ranges, 43 per cent of which is in the West, 45 per cent in the South, and 12 per cent in the central and northeastern part of the United States. About 309,000,000 acres are publicly owned or controlled and 575,000,000 acres are privately owned.

The public domain early came to be considered a great grazing commons on which no control or regulation existed,[31] and the cheap, abundant forage available thereon permitted the rapid development of a prosperous livestock industry in the West. Stockmen, under the spur of financial necessity, have practiced overgrazing on their own lands. The unreserved public domain, some 168,000,000 acres of range land in the West (Fig. 11), has lost from 40 to 50 per cent of its productivity (for the extent of depletion see Fig. 10). In many parts of the territory range deterioration has exposed the soil to abnormal erosion. In such areas local floods have increased in number and destructiveness, range productivity has been reduced as much as from 40 to 90 per cent, irrigation reservoirs and other works have rapidly silted up, thus increasing costs and threatening the permanency of irrigation farming.

To the overexpansion of the livestock industry, the disastrous wars between sheep and cattle men, overgrazing, erosion, and gradual reduction in the carrying capacity of the range, was added one last great blow at the cattle and sheep industry, the coming of the homesteader and the resulting break-up of much of the range land.

Under the assumption that the process of carving out farms could continue successfully in the semiarid regions if the 160-acre free homestead were increased, the Enlarged Homestead Act of 1911 and the Stock-Raising Homestead Act of 1916 were passed, thus permitting the entry of 320- and 640-acre homesteads, respectively. The result was a flood of new settlers who occupied the range, completely destroying the winter range in places and thus upsetting the previous interdependence of mountain summer range and the winter range of lower altitudes.* It mattered not that a high percentage of failures shortly appeared among these new homesteaders and that the abandoned entries—some 15 million acres—were frequently ruined for grazing purposes; the laws remained on the statute books and the disastrous homesteading continued. . . .

As a result of the cutting up of the ranges and the decline of their carrying capacity the stockmen have slowly come to the realization that only withdrawal of the lands from entry and the establishment of some sort of control over them will save the livestock industry. Withdrawal of the lands from entry or repeal of the entry laws will not end the overgrazing, and control of the range is therefore necessary. Private control has not worked. State control is relatively untried, but Federal con-

[30] NRB, pp. 203–205, 132–133, 20–21.

[31] See also Herman Stabler: The Rise and Fall of the Public Domain, *Civil Engineering*, Vol. 2, 1932, pp. 541–545.

* [On the system of transhumance that obtained in this area see "Agricultural Utility of Unreserved Public Domain in Nevada," mimeographed press release, 26 pp. with 2 maps, Dept. of the Interior, Washington, April 16, 1926 (noticed, with reproduction of grazing map, in *Geogr. Rev.*, Vol. 16, 1926, p. 488). Reviewer's Note.]

trol within the national forests has been successful, even according to the exacting standards of the stockmen, and therefore the conclusion is inevitable that control must be established by the Federal Government.

The demand for a change in our land policy that will put an end to improvident homesteading and establish adequate control of the public range led to the passage on June 28, 1934 (48 Stat. 1269), of the Taylor Grazing Act. This act authorizes the

RANGE LANDS WHERE CONDITIONS OF LAND USE RESULT IN DEPLETION OF FORAGE, IN EROSION, IN INJURY TO WATER SUPPLY, AND/OR IN ECONOMIC INSTABILITY*
REPORTED AS TEMPORARILY OVERGRAZED

FIG. 10

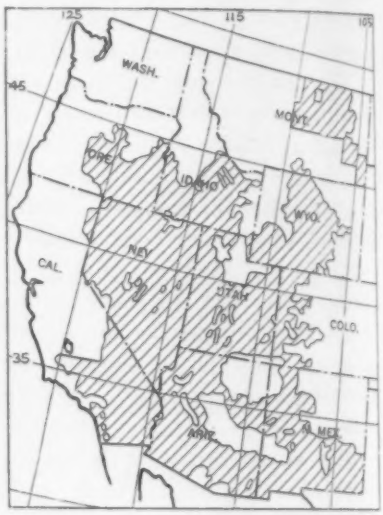


FIG. 11

FIG. 10—Range lands affected by overgrazing or other injudicious use, resulting in depletion of forage, soil erosion, and disturbance of irrigation water supplies. (Fig. 52, NRB, p. 203.)

FIG. 11—Public range lands still in Government possession. The circumstance that most of the abused area shown in Figure 10 still lies in the public domain as shown in this figure will make possible control of grazing in that area when the provisions of the recently enacted Taylor Grazing Act are carried out. (Stabler, Fig. 9 in paper cited in footnote 31.)

withdrawal from entry of 80,000,000 acres of vacant, unreserved, unappropriated public domain and its organization into grazing districts to be administered by the Department of the Interior. It also authorizes administration of grazing on land included in withdrawals amounting to about 30,000,000 acres insofar as grazing is consistent with the purposes of the withdrawal. Furthermore, where the public domain occurs in isolated, disconnected tracts, the land is made subject to grazing leases under such conditions as may be deemed necessary or appropriate by the Secretary of the Interior.

. . . A Division of Grazing has been created in the Department, a Director of Grazing Control appointed, and an administrative organization is being established.

RECREATIONAL LAND[32]

The measurement of recreational requirements merely in terms of acres would obviously be misleading. More significant are the character and accessibility of the land employed; and much depends on the type of recreation to be provided.

Any program of recreational land utilization must consider partic-

[32] NRB, pp. 144–147, 217–221, 13–14, 22–23.

ularly the needs of the city dweller. The enormous concentration of population in urban agglomerations is illustrated by the following deductions from the 1930 census. Three-fifths of the total population growth in the large cities of the country (lower size limit not given) occurred in five well-defined urban areas which increased 36 per cent between 1920 and 1930 as compared with a 9 per cent increase for the remainder of the United States and 17 per cent for the metropolitan districts not included in these five areas. Furthermore, over three-fifths of the increase in these five areas is found in two of them, namely the metropolitan districts of the Middle Atlantic seaboard from New York to Baltimore and the metropolitan districts of the Great Lakes region from Buffalo to Milwaukee. The metropolitan portions of these two groups now have about 27,000,000 people concentrated on about 12,000 square miles. Three hundred and ten cities in the United States, with a population of 30,000 and over, occupy 4,345,000 acres. A total of 47,395,000 inhabitants, or about 38 per cent of the total population, is crowded on 0.2 per cent of the total land area of the United States! In view of this intense urban concentration, the matter of proximity should be taken into account in the provision of recreational areas.

For city dwellers municipal parks constitute the principal means of year-round recreation out of doors. In 1930 there were 309,000 acres devoted to this purpose in 1072 cities with a population of 5000 or more. The average ratio of this park area to the total population of these cities was about one acre to every 200 persons. Twice this acreage should be aimed at as the desirable ratio. County parks exist in 74 counties of the United States, mainly in metropolitan areas, and total about 100,000 acres. This should be increased, as well as the recreational areas in metropolitan districts (defined by the Census Bureau as a central city and all adjacent civil divisions having a population density of not less than 150 inhabitants to the square mile), of which there are 96 in the United States, but only 6 of which have special metropolitan park districts. The total area of State Parks (distributed in 44 States) is 3,800,000 acres. Although they contain less than a fourth as much area as the National Parks, they are visited annually by a far larger number of people, estimated as 45,000,000 in 1930. It is recommended that County and State park systems combined should be increased to 10,000,000 acres.

The extensive areas in Federal ownership, including the public domain (165,000,000 acres), the 15,000,000 acres in National Parks, Monuments, Historic Sites and Memorials, and the 130,000,000 acres in National Forests constitute a vast potential though somewhat poorly distributed recreational system in most of which recreation is subordinated to other major uses. Certain additions should be made to the National Park system, mainly by transfer from other Federal

administrative agencies. The preservation of outstanding historical and archeological sites of national importance (as compared with those of more local interest, properly the concern of the States) and superlative examples of primeval areas is a responsibility of the Federal Government. Primeval areas, most of which have been set aside in the National Forests, are defined as unmodified tracts of land with accompanying plant and animal life where the normal processes of nature continue undisturbed by man and where all forms of natural life are given sanctuary—in other words an area where ecological processes are not modified by artificial treatment. The Science Advisory Board's report advocates (pp. 211–212) the further segregation and intensive study of such natural, primitive, or wilderness areas as part of its larger recommendation of applying ecological research to land problems—in the management of wild land, forest land, and unimproved lands that have been subjected to exploitation (pp. 204–214).

Wild-Life Resources[33]

The wild-life resources of the Nation annually provide meat and fur valued at $200,000,000. Expenditures by hunters (estimated total of 13,000,000 hunters and fishermen, of whom 7,000,000 were licensed hunters in 1929) and by tourists attracted chiefly by an abundance of game aggregate over $400,000,000 annually. In addition wild life is of incalculable value in destroying insects preying upon agricultural crops and forest trees.

For the protection and conservation of wild life State and Federal refuges of one kind or another are already available. The National Parks and some 25,000,000 acres within the National Forests have been given such designation, of which about 21,000,000 acres are under State jurisdiction. The Biological Survey administers over 100 refuges, mainly for birds, aggregating 800,000 acres, and protects for the same purpose reservoir sites totaling 1,200,000 acres, developed by the Bureau of Reclamation. The Biological Survey estimates that an additional 17,000,000 acres of swamp and marsh lands that can serve no other important purpose should be provided with special wild-life administration. The 49,000 acres of the Pribilof Islands are administered by the Bureau of Fisheries primarily for the conservation and utilization of fur seals, and 500,000 acres in Alaska serving other primary uses have been given wild-life-refuge status.

So far recognition of wild life as a national asset has been centered on conservation. Greater attention should now be devoted to management. While emphasis on conservation has produced such situations as an overabundance of game in one region and a scarcity in another, game management consists largely in the regulation of num-

[33] NRB, pp. 148–150, 222–226, 14, 23.

bers in accordance with the food supply, with due regard for other local interests, in producing maximum numbers of desired species, and in controlling the number of undesirable species and damage caused by them.

Water Resources

Water resources may be considered under three heads: their nature, their use, and their control. The report of the Water Planning Committee (Part III of the National Resources Board's report) and the report of the Mississippi Valley Committee contain a wealth of material on all these, much of which is brought together for the first time.

Of the precipitation that reaches the surface of the ground some immediately runs off over the surface and is carried away by streams and rivers, some is evaporated from the ground or water surfaces, and some percolates into the ground. Both that which reaches the ground and that which runs off are shown on two newly compiled maps of average annual precipitation and average annual runoff in the United States on the scale of 1 : 12,000,000.[34] A cartogram on the same scale contains regionally distributed runoff graphs from typical drainage areas.[35] Runoff data are collected at nearly 3000 gauging stations by the U. S. Geological Survey throughout the country.[36] It is recommended that they be increased at least 10 per cent in number. Ground water is a resource even more important than surface water over much of the country.[37] Agricultural activities, rural development, and, especially in times of drought, the flow of surface streams are dependent on subsurface water. A progressive decrease in ground-water level has been taking place in many sections of the country; in the Dakotas the decline amounts to as much as 30 feet.[38] The presence of dissolved mineral matter in streams is a matter of consequence because of the high cost of softening the water to make it suitable for industrial uses. The distribution of hardness of surface- and ground-water supplies and of iron in underground waters is indicated on three maps.[39]

Turning first to irrigation in a consideration of water use we find that only 14,000,000 acres out of 168,000,000 acres of cropland are irrigated in the 17 western states having inadequate rainfall.[40] "Neither the agricultural situation as a whole nor the situation on the

[34] NRB, facing pp. 292 (referred to in footnote 13 above) and 300. A map of runoff in the United States, 1 : 15,000,000, based on U. S. Geological Survey records, accompanies Henri Baulig: Ecoulement fluvial et dénudation d'après les travaux de l'United States Geological Survey, *Annales de Géogr.*, Vol. 19, 1910, pp. 385–411. Subsequently the standard maps of precipitation and runoff (1 : 16,000,000), by Henry Gannett, appeared as Pls. 1 and 2 in each of *U. S. Geol. Survey Water Supply Papers* Nos. *301* to *312*, 1912 to 1915.

[35] NRB, facing p. 302.

[36] Map showing their location, NRB, facing p. 304.

[37] On surface water and ground water see also SAB, pp. 214–218.

[38] Map, NRB, p. 309.

[39] NRB, facing p. 312.

[40] MVC, pp. 74–80, with irrigation map facing p. 74; NRB, pp. 343–344.

irrigated lands justifies Federal action to extend the irrigated area."[41] Irrigation of another sort, which may be termed supplemental irrigation, is practiced in the ordinarily humid regions of the East and South, where it is used to overcome insufficient natural rainfall at critical periods in the development of a given crop.[42]

The most important form of water-derived power is hydroelectric power.[43] The elements of the problem are as follows. Only one-sixth of the country's water power has been harnessed and only 13 per cent of our 6,200,000 farms have electricity, whereas 64 per cent of the farms have automobiles. The average charge to consumers in the United States in 1934 was 5.49 cents per kilowatt hour. In 26 cities of Ontario the average charge was 1.45 cents. Yet, whereas from the long-run viewpoint the desirability of conserving coal, gas, or oil makes the full utilization of all available water power seem highly desirable, from the short-term commercial viewpoint the comparative merits of water and fuels as sources of electric power wear a different complexion. As a result of the recent great improvements in furnaces and engines, the low present prices for fuels, and the possibility of building the fuel electric plants near the markets for current and yet where fuels can be delivered cheaply, it is commonly less costly to provide electricity by combustion methods than by harnessing water power and building transmission lines. Nevertheless considerable progress has been made in the creation of such circuits.[44]

The outstanding problem in water control is flood control.[45] Destructive inundations may occur at any time in any section of the country. The aggregate direct damage by them has been estimated to average $35,000,000 annually. Flood-control works are of four general types: (1) storage reservoirs, to impound flood waters for later release; (2) retarding basins, automatically to retard and smooth out flood peaks; (3) channel improvements, to increase capacity or facilitate flow; (4) levees, to protect from overflow the bottom lands behind them. As regards the area most subject to inundation, the Lower Mississippi region, the Federal Government, following the failure of the levee system during the great flood of 1927, adopted in 1928 a plan (1) for levees that normally will confine the river to its main channel and back-water areas and (2) for floodways, aggregating some 4000 square miles in extent, that will carry part of the water of high floods expected to occur on an average every 13 years. Other questions relating to control are provision for an ample supply for domestic use and prevention of pollution of waters through proper sewage disposal.[46]

[41] MVC, p. 6.

[42] NRB, pp. 374–376; MVC, p. 7.

[43] NRB, pp. 38–40, 347–352; MVC, pp. 4–5, 45–53.

[44] Map of main electric transmission lines, NRB, facing p. 350.

[45] MVC, pp. 207–210, 21–23, 27–29; NRB, pp. 325–329, 282–283.

[46] MVC, pp. 57–60, with pictorial diagram (facing p. 58) of typical river basin under existing conditions and with conditions corrected; NRB, pp. 330–332, 314–315, and 333–339.

Both reports also contain a number of regional sections in which the various aspects of water use are discussed in their areal relationship. The unit of area employed is a river basin. While this type of unit lends itself well to the hydrologic-engineering problems that

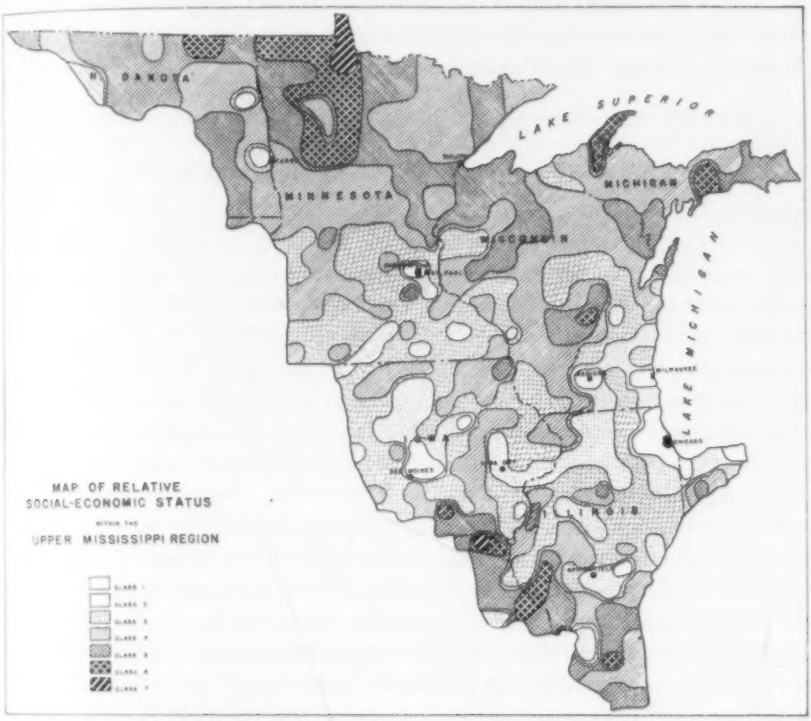


FIG. 12—Isopleth map of the relative economic status of the population in the Upper Mississippi region. In compiling the map each of the 371 counties in the region was rated on a scale of 1 to 7 in respect to 24 characteristics indicative of economic trends during the decade 1920–1930, prior to the depression. Of these characteristics 2 related to population, 4 to farm abandonment, 2 to gross productivity, 16 to net income and standard of living. The separate ratings in respect to these 24 characteristics were then weighed and combined into one composite rating for each county and the county pattern generalized by isopleths (rating 1 to 7 in decreasing order of well being; see key). (Map on p. 132, MVC.)

originally led to its selection, such as the construction of dams and reservoirs, its geographical inappropriateness is well illustrated by the excellent colored-population-density (1930) and population-movement (1920 to 1930) maps of the Mississippi-Missouri basin that accompany the Mississippi Valley Committee's report.[47] The abrupt stopping of the density tints, especially at the Atlantic-Gulf and Gulf-Great Lakes divides, accentuates the artificiality of the image. The density map is an isopleth map; in this connection it is of interest to note that the Science Advisory Board's contribution to the National Resources Board's report[48] advocates the discontinuous-tint method of the Rus-

[47] MVC, facing pp. 2 and 4, maps in 1 : 12,000,000.
[48] NRB, p. 25.

sian "dasymetric" maps and of the recent population map of Great Britain on the scale of 1 : 1,000,000 published by the Ordnance Survey as more closely reflecting the actual disposition of population than the isopleth method with its uninterrupted gradational density sequences.

The Mississippi Valley Committee's report also contains an interesting experiment in the form of a socio-economic map of the Upper Mississippi basin reproduced herewith (Fig. 12).

Mineral Resources[49]

In introducing its contribution to the report of the National Resources Board, the Planning Committee on Mineral Resources (see Appendix) calls attention to the importance of the mineral industry and to the fact that it has developed without the aid of any consistent national policy.[50] The facts that warrant special consideration for the mineral industry and a unified policy for its guidance, according to the Committee, are: (1) that minerals are exhaustible and nonreproducible; (2) that some minerals do not exist in the United States in quantities adequate for national welfare; (3) that others exist in present surplus; (4) that geographic distribution is fixed by nature and cannot be changed by enactment, thereby determining trade routes and trade areas, both domestic and foreign; (5) that there are special hazards, both physical and economic, in mining; (6) that closing down a mine may result in losses far more serious than closing down a factory.

Mineral resources have been a major factor in American industrial development. The country was endowed with a magnificent abundance and variety of minerals that provided cheap metal with which to make machines and cheap fuel with which to drive them. By the turn of the century, the United States had come to lead all other nations in both the production and use of mineral raw materials. In 1929 the mineral industries employed more than a million men and reported products to the value of six billion dollars.

However, the World War revealed American dependence on foreign supplies of certain critical materials. With regard to the international aspects of a minerals policy, the Committee recommends:

> With respect to minerals of which the United States has a present exportable surplus: (1) give fitting consideration in negotiation of commercial agreements; (2) seek fair tariff and trade treatment by foreign governments; (3) maintain the Webb-Pomerene Act; (4) permit American participation when desirable in international cartels; (5) avoid artificial stimulation of exports by special concessions in freight rates or shipping subsidies not extended to other commodities; (6) discourage importations which aggravate anticonservational conditions of surplus development.
>
> With respect to minerals for which the United States is largely dependent on foreign sources: (1) consideration of existing tariffs in the light of domestic reserves;

[49] NRB, pp. 389–449, 31–37.

[50] Compare The Mineral Inquiry's "Elements of a National Mineral Policy," New York, 1933; reviewed by A. C. Veatch, *Geogr. Rev.*, Vol. 24, 1934, pp. 338-340.

(2) protection of American interests against attempts to maintain excessive prices on our needed imports, by the operation of cartels, intergovernmental agreements, export duties, or other restrictions; (3) restriction or regulation of the export of scrap; (4) establishment of war reserves of imported minerals essential for national defense; (5) maintenance of trading lines carrying these minerals.

The magnitude of waste of the Nation's resources is clearly indicated by this brief statement from the Committee's report:

It is probable that during the time it would take the ordinary person to read over this report (fifty printed pages) enough fuel will have been wasted in our gas and oil fields and coal mines to keep at least 10,000 relief families warm during the coming winter. . . .

It is now established beyond reasonable doubt that the United States is deficient in many minerals necessary for industry, both in respect to present and to future requirements; that for others the supply is limited to a decade or a few decades; that, aside from the building materials, only a few of the minerals such as coal and iron exist in quantities sufficient to supply the Nation for long periods of 100 years or more, and even these are more limited in regard to the higher grade reserves.

Present overdevelopment of some minerals has tended to obscure the central and dominant fact that, in relation to what we hope will be the life of the Nation, our mineral supplies are too limited to excuse the wasteful exploitation that now often prevails.

To cite one specific case, petroleum. At present (1934) the proved reserves of oil recoverable by usual methods of production are estimated to be about 13 billion barrels. These would last approximately 15 years at the 1933 rate of consumption. However, since some of the oil included in these reserves cannot be produced until 20 or 30 years hence (because of the decline in rate of production as a well grows older), a shortage during the coming 15-year period can be prevented only by discovery of new fields.[51]

New production to postpone the day of shortage will no doubt be found, but sooner or later the Nation's output of oil from wells will be insufficient to meet the demand. The United States is depleting its supply of oil at a more rapid rate than any other country that possesses oil reserves of major importance.

In conclusion the following statement of the Committee's views on ownership may be cited.

We believe that the record of the mineral industry in the United States warrants the presumption that it should continue to develop under private initiative. However, we also believe that mineral reserves are vested with a public interest which justifies extension of public supervision to those specific conditions affecting our mineral industries, which are distinctly detrimental both to the public and to the industries themselves, and which seem beyond the power of the industries themselves to remedy.

[51] See testimony and report of H. B. Soyster, U. S. Geological Survey, *in* Parts 1 and 2 of Petroleum Investigation Hearings before Subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, 73d Congr., on H. Res. 441.

Defining "public supervision" in relation to the mineral industries, the Committee says:

> By public supervision we mean not so much the forcible public interference with private business, as the addition of safeguards and powers to enable industry itself to act collectively, where necessary, in order to avoid the wastes, physical and social, of destructive competition.

Topographic Mapping

The outstanding need, because basic to all planning and an ordered national life, is the completion of the topographic map of the United States. The fact is now so well known that it has become trite that only 50 per cent of the continental United States is covered by topographic maps and only 26 per cent, according to the estimate of the responsible mapping agency, is adequately mapped for present needs (Pl. II).[52] This situation calls for, and is amenable to, rapid remedy.

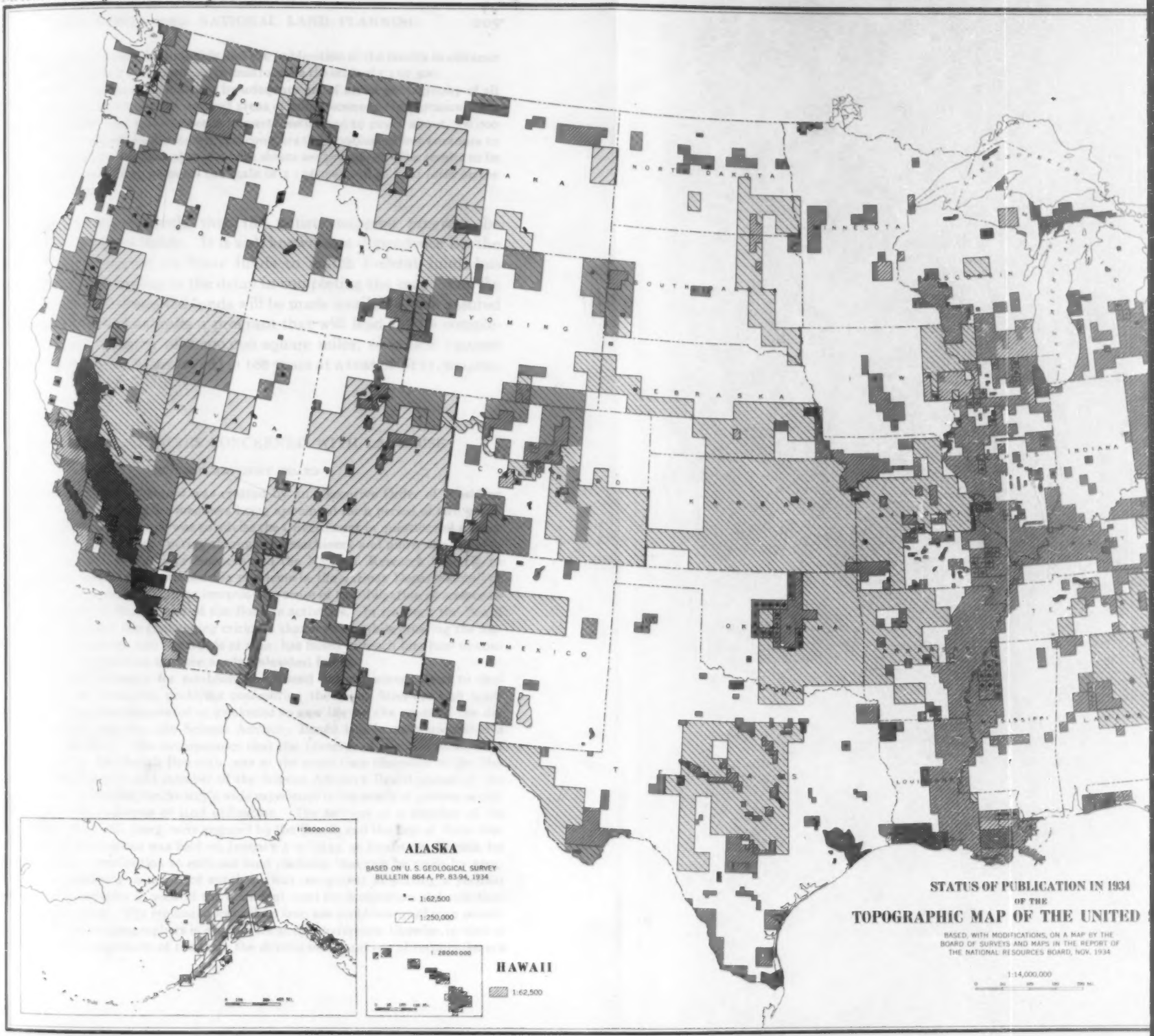
The Board of Surveys and Maps, in a report to the National Resources Board dated October 29, 1934[53] advocates the use of aerial photography for the rapid completion of the map, recommending compilation from aerial photographs differentiated as follows in field and publication scales according to type of land covered:

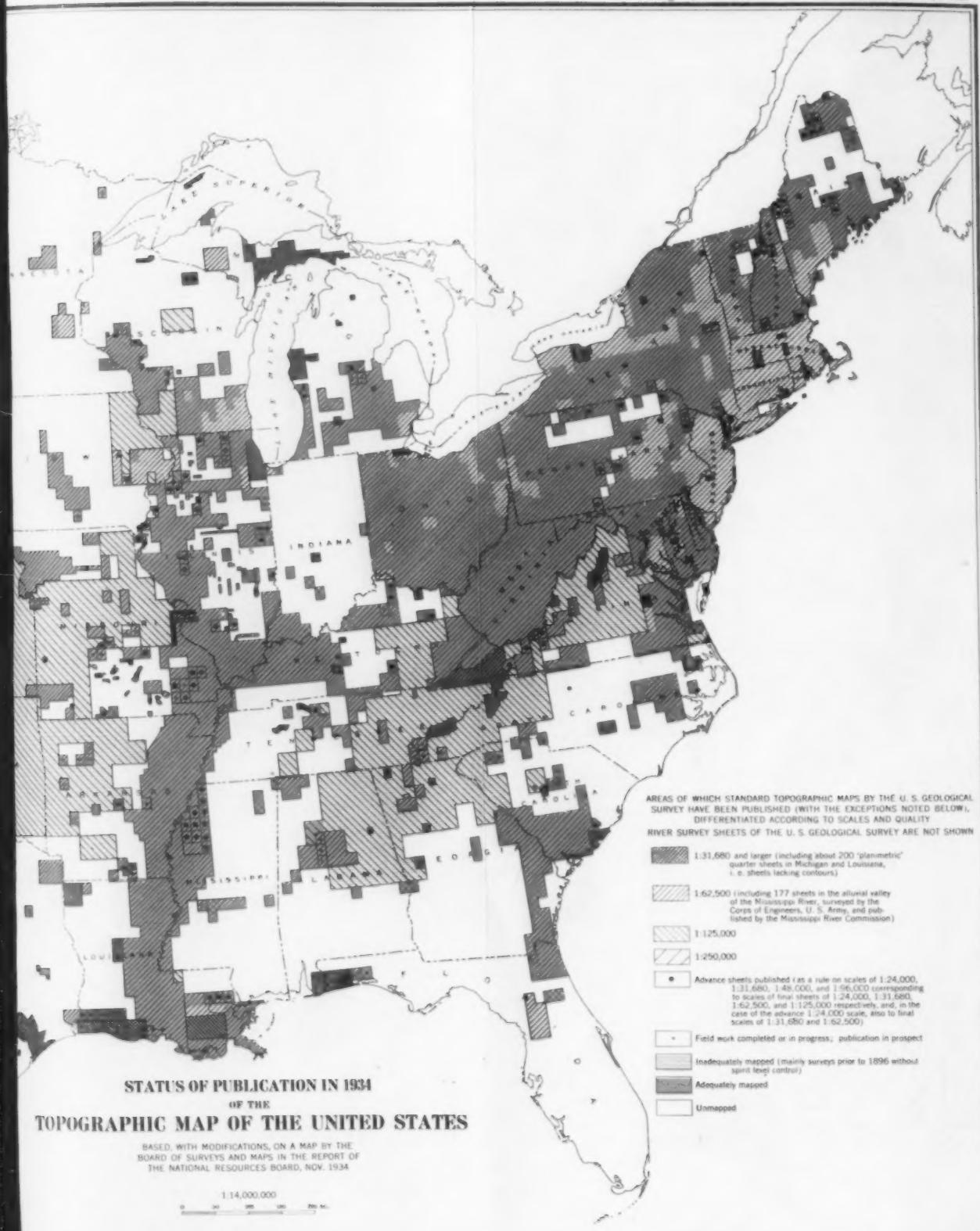
> (1) The compilation of planimetric base maps from aerial photographs taken on a scale of about 1 : 20,000 of all of the unmapped or inadequately mapped agricultural lands in the Eastern and Southern States, where the boundaries of farms and fields are irregular in shape, and most fields are relatively small, and of other areas of extreme economic importance, estimated to cover in all about 300,000 square miles; the publication of preliminary sheets without contours on a scale of 1 : 24,000; and the preparation of contour maps as soon as practicable after the planimetric maps are available and the publication of the results in advance sheet form on the scale of 1 : 31,680 and in final form on a scale of 1 : 62,500.
>
> (2) The compilation of planimetric base maps from aerial photographs taken on a scale of about 1 : 31,680 of all of the unmapped or inadequately mapped agricultural lands in States where individual farms and fields are relatively large and regular in shape, and of other areas of moderate economic importance, estimated to cover in all about 1,216,000 square miles; the publication of preliminary sheets without contours on the scale of 1 : 31,680; and the preparation of contour maps as soon as practicable

[52] Plate II is a slightly modified reproduction of the map in 1 : 11,600,000 facing NRB p. 452, to which has been added the topographically surveyed area of Alaska (based on *U. S. Geol. Bull. 864A*, pp. 83–94) and of Hawaii.

It is of interest to note that the NRB map is the first official map ever published *adequately* showing the status of the topographic map of the United States (i.e. expressed in terms of quality and differentiated according to scales). During the preparation of its contribution to the NRB report the Science Advisory Board in September, 1934, urged the preparation of such a map and supplied specifications for it. The last of a series of official index maps differentiating the surveyed area according to scales is the map accompanying the *45th Annual Rept. of the Director of the U. S. Geol. Survey for 1923–24*, Pl. I. Subsequent index maps published in the Annual Reports of the Survey do not differentiate according to scales. However, a map in 1 : 12,000,000 prepared by R. Bitterling with the aid of information supplied by the United States Geological Survey (Plate 22 of his article: United States Geological Survey und ihr topographischer Standardatlas, *Geogr. Anzeiger*, Vol. 33, Gotha, 1932, pp. 359–371) does differentiate according to scales and was prior to the publication of the NRB map the latest and best map representing the status of the topographic map of the United States.

[53] NRB, pp. 451–455.


NORTH DAKOTA
MINNESOTA
WYOMING
NEBRASKA
INDIANA
NEW MEXICO
1:58000000
ALASKA
BASED ON U. S. GEOLOGICAL SURVEY
BULLETIN 864 A, PP. 83-94, 1934
1:62,500
1:250,000
1:28000000
HAWAII
1:62,500
STATUS OF PUBLICATION IN 1934
OF THE
TOPOGRAPHIC MAP OF THE UNITED
BASED, WITH MODIFICATIONS, ON A MAP BY THE
BOARD OF SURVEYS AND MAPS IN THE REPORT OF
THE NATIONAL RESOURCES BOARD, NOV. 1934
1:14,000,000


LAKE SUPERIOR
INDIANA
AREAS OF WHICH STANDARD TOPOGRAPHIC MAPS BY THE U. S. GEOLOGICAL SURVEY HAVE BEEN PUBLISHED (WITH THE EXCEPTIONS NOTED BELOW), DIFFERENTIATED ACCORDING TO SCALES AND QUALITY
RIVER SURVEY SHEETS OF THE U. S. GEOLOGICAL SURVEY ARE NOT SHOWN
1:31,680 and larger (including about 200 'planimetric' quarter sheets in Michigan and Louisiana, i. e. sheets lacking contours)
1:62,500 (including 177 sheets in the alluvial valley of the Mississippi River, surveyed by the Corps of Engineers, U. S. Army, and published by the Mississippi River Commission)
1:125,000
1:250,000
Advance sheets published (as a rule on scales of 1:24,000, 1:31,680, 1:48,000, and 1:96,000 corresponding to scales of final sheets of 1:24,000, 1:31,680, 1:62,500, and 1:125,000 respectively, and, in the case of the advance 1:24,000 scale, also to final scales of 1:31,680 and 1:62,500)
Field work completed or in progress; publication in prospect
Inadequately mapped (mainly surveys prior to 1896 without spirit level control)
Adequately mapped
Unmapped
STATUS OF PUBLICATION IN 1934
OF THE
TOPOGRAPHIC MAP OF THE UNITED STATES
BASED, WITH MODIFICATIONS, ON A MAP BY THE BOARD OF SURVEYS AND MAPS IN THE REPORT OF THE NATIONAL RESOURCES BOARD, NOV. 1934
1:14,000,000

after the planimetric maps are available and the publication of the results in advance sheet form on the scale of 1 : 48,000 and in final form on the scale of 1 : 62,500.

(3) The compilation of base sheets by adequate use of aerial photography of all other unmapped or inadequately mapped areas of minor economic importance, such as rugged mountains and sparsely settled deserts, estimated to cover about 700,000 square miles; no preliminary sheets without contours to be published but contours to be added as soon as practicable after the base sheets are prepared. The results to be published in advance sheet form on the scale of 1 : 96,000 and in final form on the scale of 1 : 125,000.

The Board recommends that the entire mapping program be financed from Federal funds. It is well known that dependence by the U. S. Geological Survey on State funds to match Federal funds has been a cause contributing to the delay in completing the map. On the assumption that the required funds will be made available with assured regularity the Board submits a program that will lead to the completion of the map (survey of 2,200,000 square miles, of which 740,000 square miles are to be resurveyed) in ten years at a cost of $117,500,000.

APPENDIX: AGENCIES CONCERNED WITH LAND USE

SCIENCE ADVISORY BOARD

The Science Advisory Board was created by an Executive Order of President Roosevelt on July 31, 1933, its members being appointed for a period of two years. The task assigned to the Board was to advise the Government in questions of science and it was hence authorized, "acting through the machinery and under the jurisdiction of the National Academy of Sciences and the National Research Council, to appoint committees to deal with specific problems in the various Departments" of the Federal Government. From its inception its sense of the obligation of science to society has governed the conduct of the Board's activities. In its work the Board has attempted to meet the challenging criticism that science, while creating the machine and putting power into the hands of man, has failed to teach him how to control the social consequences of these newly unleashed forces.

Realizing the necessity for establishing a sound natural-science basis to deal properly with the economic problems confronting the many land-use and land-planning agencies recently created or awakened to new life by the needs of the national emergency program, the Science Advisory Board late in 1933 appointed a Land Use Committee. The circumstance that the Director of the American Geographical Society, Dr. Isaiah Bowman, was at the same time chairman of the National Research Council and member of the Science Advisory Board placed at the disposal of the committee the Society's wide experience in the study of pioneer settlement and kindred problems of land utilization. The services of a member of the Society's staff, W. L. G. Joerg, were engaged by the Board, and the first of three conferences under its auspices was held on January 5–7, 1934, at Evanston, Illinois, for discussion of the contribution to national land planning that can be made by geography. Its underlying principle of synthesis was recognized as placing a peculiar obligation on geography in view of the dominant need for integration and coördination in land planning. The regional approach to land use problems was hence recommended by the seven geographers in attendance at the conference; likewise, in view of the urgency and magnitude of the task, the development and use of reconnaissance

inventory methods were advocated to replace the detailed inventory methods at present in vogue.

There followed the invitation of the Science Advisory Board to Dr. Sauer to prepare a report on land use in the United States (see footnote 1). This report was completed in April and formed the basis of discussion at a second conference of geographers, held under the chairmanship of Dr. Sauer at Chicago on May 2–4, at which eleven were present, including five members of the Evanston meeting.

The groundwork in exploring the field of land utilization from the standpoint of geography thus having been laid, it was opportune to submit these findings to the bodies most directly concerned and to solicit their joint discussion of the whole problem. On the invitation of the Science Advisory Board, and with Dr. Bowman as chairman, a conference was held on June 14 at the National Academy of Sciences in Washington, which was attended by 24 representatives of sixteen Government agencies, including Secretary of Agriculture Wallace and Dr. A. E. Morgan, chairman of the Tennessee Valley Authority. Among the topics dealt with at the conference were: the close interdependence of the natural and the social sciences in the consideration of land-use problems; the need for further knowledge and at the same time the frequently occurring practical necessity for making administrative decisions with the knowledge immediately at hand, insufficient though it might be; the desirability of carrying on concurrently emergency work and long-range planning; and the need for developing methods and procedures for bringing about greater stability in land use than our inherited economic and legal concepts, derived from climatically stable Western Europe, have as a rule produced in a country two thirds of which is "set on an ecological hair trigger" (Aldo Leopold).[1] At the request of Mr. Charles W. Eliot, 2nd, executive officer of the National Planning Board, it was in conclusion decided that the Science Advisory Board would, in the field of natural science, assist the National Planning Board in the survey it was undertaking of the major problems of land use and the existing agencies qualified to attack these problems and, in so doing, would pay special attention to the priorities of importance among research problems, priorities that the Board had especially advocated.

In carrying out this assistance the Land Use Committee of the Science Advisory Board prepared a concise report, based mainly on the report Dr. Sauer had prepared for the Board. This dealt with such topics as topographic mapping, climatic risks, air-mass studies and phenologic surveys as aids in climatological research, the new method of surface and slope investigation in its bearing on soil erosion, the study of vegetational degeneration in the overgrazed range lands as a basis for remedial measures, population distribution and movement, and the regions most in need of readjustment. This report was incorporated in Part II of the report of the National Resources Board, of which the general summary, constituting Part I, was transmitted to the President on November 28, 1934.

NATIONAL RESOURCES BOARD AND ITS PREDECESSORS

The National Resources Board was established by Executive Order on June 30, 1934, there being transferred to it all of the powers, duties, records, personnel, equipment, and funds of the National Planning Board, which was at the same time abolished. "The functions of that Board shall be to prepare and present to the President a program and plan of procedure dealing with the physical, social, governmental, and economic aspects of public policies for the development and use of land, water, and other national resources, and such related subjects as may from time to time be referred to it by the President." One of the specific tasks laid upon the Board was to "submit a report on land and water use on or before December 1, 1934." In

[1] A 19-page mimeographed "Digest of Discussion at Conference on Land Use, Washington, June 14, 1934" was issued by the Science Advisory Board at the National Research Council, Washington.

addition to an advisory committee, provision was made for the setting up of technical committees. Three have so far been established: a Land Planning Committee, of which Dr. M. L. Wilson, Assistant Secretary of Agriculture, and Dr. L. C. Gray, of the Bureau of Agricultural Economics, are respectively chairman and director; a Water Planning Committee, of which Morris L. Cooke is chairman and Professor Harlan H. Barrows, head of the Department of Geography at the University of Chicago, is a member; and a Planning Committee on Mineral Policy, of which Secretary of the Interior Harold I. Ickes, who is also chairman of the National Resources Board, is chairman and Dr. C. K. Leith of the University of Wisconsin is vice-chairman.

The Water Planning Committee originally was the Mississippi Valley Committee, a unit of the Public Works Administration appointed by Secretary Ickes in September, 1933, in his capacity as Administrator of Public Works. The Planning Committee on Mineral Resources[2] was originally appointed on April 1, 1934, by President Roosevelt, who acted on a suggestion from the Science Advisory Board. The President's letter of appointment stated it to be the purpose of the committee to consider such questions as the estimating of future consumption, the curtailment of production, the coördination of emergency appropriations, the relationship between Federal and State control, the treatment and conservation of the Nation's mineral resources, and the effect of mineral tariffs—in short to undertake a general study of the mineral resources of the United States with a view to establishing a national mineral policy. Upon the creation of the National Resources Board on June 30, 1934, the committee also became the mineral committee, coordinate with the land and water committees, of that Board. Acting in this second capacity, the mineral committee has contributed Part IV to the report of the Board. The committee retains its identity as a committee of the Science Advisory Board and in this capacity will later submit a separate report.

NATIONAL PLANNING BOARD

The National Planning Board, of which the National Resources Board is a direct outgrowth, was appointed on July 20, 1933, by the Administrator of Public Works. It consisted of three members, Frederic A. Delano (chairman), Charles E. Merriam, professor of political science, University of Chicago, and Wesley C. Mitchell, professor of economics, Columbia University, and councilor of the American Geographical Society. These three members later continued as the advisory committee of the National Resources Board. The main work of the National Planning Board has been the stimulation of city, regional, and state planning activities. The Board was instrumental in bringing about the appointment of planning boards in a large number of states. Agencies of this type now exist in 42 states. To about 27 of these state planning boards consultants were assigned by the national board. One of their main tasks has been to prepare a preliminary report dealing with land use, the integration of transportation methods, and a ten-year public works program for the state to which they were assigned.

NATIONAL LAND USE PLANNING COMMITTEE

Although the National Planning Board was appointed in 1933 a considerable amount of work relating to its field, especially in land use planning, had already been done by two committees that had been set up in 1931. As a result of a resolution adopted by the National Conference on Land Utilization, which had met in Chicago,

[2] For the antecedents of this action and the contributory activities of Dr. C. K. Leith, member of the Science Advisory Board appointed vice-chairman of the committee, the reader is referred to SAB, p. 32.

November 19–21, 1931,[3] at the joint call of the then Secretary of Agriculture and the Association of Land-Grant Colleges and Universities, a National Land-Use Planning Committee and a National Advisory and Legislative Committee on Land Use were appointed. The former consisted of 16 members from the departments of Agriculture and the Interior, the Federal Farm Loan Board, and the Association of Land Grant Colleges and Universities and was designed to represent various official agencies of the Federal and State governments, having to do with land administration and research. The latter consisted of 28 members representing various unofficial agencies having important interests in land problems. Its function was mainly to interpret and arouse public opinion and to recommend appropriate legislation. The National Land Use Planning Committee issued a series of mimeographed publications some of which contain the results of the work of its technical subcommittees,[4] twelve of which had been set up. After a period of two years the committee was discontinued on November 11, 1933. In the last six months of its existence "national developments had made it possible to obtain action with a degree of celerity not anticipated at the time the Land Use Committees were formed."[5] The committee therefore had every reason to believe that its work would be carried on even more intensively through the newly created agencies. Indeed ultimately two of its members became members of the Land Planning Committee of the National Resources Board and quite a number of members of its technical subcommittees contributed in the preparation of the Board's report.

SOME OTHER AGENCIES CONCERNED WITH LAND USE

In addition to these recently established boards and committees that have been publishing reports there is a considerable number of agencies, both old and new and within and without the Government, that are concerned with land use.

Among the long-established Federal agencies[6] the Bureau of Agricultural Economics, and especially its Land Economics Division, the Soil Survey Division of the Bureau of Chemistry and Soils, the Conservation Branch of the U. S. Geological Survey, and the Forest Service have especially occupied themselves with land classification and land use. Among the new agencies the Program Planning Division, especially its Land Policy Section, of the Agricultural Adjustment Administration, the Land Planning Division of the Tennessee Valley Authority, and the Soil Erosion Service of the Department of the Interior are perhaps those most particularly concerned with land use and planning. There are geographers on the staffs of the first two of these, and geographers have served and are serving as consultants to these organizations. In the Division of Geology and Geography of the National Research Council there is a Committee on Land Classification, of which Professor Kenneth C. McMurry, of the Department of Geography of the University of Michigan, is chairman and of which three of its other four members are professional geographers. As to State agencies perhaps the three outstanding ones prior to the establishment of the 42 planning boards referred to above were the Michigan Land Economic Survey, the Wisconsin Committee on Land Use and Forestry, and the Minnesota Committee on Land Utilization, each of which has published valuable reports.

[3] The 36 papers read at that conference were published as Proceedings of the National Conference on Land Utilization, Chicago, Ill., November 19–21, 1931, 251 pp., U. S. Dept. of Agric., Washington, 1932. They deal with land utilization, the use and misuse of land, the place of forestry in a national land utilization program, adjustment in farming methods, tax delinquency, and rural credit.

[4] Three of these are especially valuable: Conservation of the Grazing Resources of the Remaining Public Domain (21 pp.; *Publ. No. 4*, March, 1933); The Problems of 'Submarginal' Areas, and Desirable Adjustments With Particular Reference to Public Acquisition of Land (24 pp.; *Publ. No. 6*, 1933—printed, not mimeographed); Scope and Character of a National Cooperative Research Project in Land Utilization (15 pp.; *Publ. No. 8*, August, 1933). Nine publications were issued in all.

[5] Final Report of National Land-Use Planning Committee, *Publ. No. 9*, p. 5.

[6] A comprehensive list of Federal agencies and their functions is given in NPB, pp. 75–81.

THE EVOLUTION OF LAND UTILIZATION IN LEBANON, NEW HAMPSHIRE

Edward N. Torbert

[With separate map, Pl. III, facing p. 230]

FIG. 1—Land grants made by Governor Wentworth of New Hampshire, 1760–1764 (shaded), including the town of Lebanon (solid black).

The town of Lebanon, New Hampshire, presents typical features of the northern New England landscape—the thriving dairy lands and pine-clad old fields, the gaping cellar holes of abandoned hill farms and the populous industrial center in the valley below. In the contrasting features of this one town may be traced the general evolution of land use in New England. In particular Lebanon affords opportunity for study of the shift from farm to factory, contrasting markedly in this respect with the near-by town of Lyme, whose story is graphically recounted as "A Town That Has Gone Downhill."[1]

EARLY SETTLEMENT

The first mark of permanent settlement in Lebanon was a log cabin built during the fall of 1762 on a wooded flat of the Connecticut River. The builders were among the first of hundreds who came from eastern Connecticut to Lebanon and other wilderness towns of the upper middle Connecticut Valley. Need for new land brought many; for in that long-settled part of Connecticut from which they came farms had early been subdivided into holdings that yielded a bare subsistence. Migration before 1760 had been discouraged by the menace of Indian attack; but at the close of the French and Indian War many young people, in quest of those promising valley lands reported by farmer militiamen, pressed northwards along the Connecticut River corridor.

Migration was quickened by attractive offers from speculative proprietors of new towns. These towns—wilderness tracts of about thirty-six square miles each—were granted in such rapid succession by Governor Wentworth of New Hampshire that in the five years 1760–1764 a vast area (see Fig. 1) was thrown open for settlement. Under the spur of keen competition the proprietors of each new town offered the prospective settler many inducements. Among other

[1] By J. W. Goldthwait, *Geogr. Rev.*, Vol. 17, 1927, pp. 527–552.

things, the 62 proprietors of Lebanon had a "horse road" cleared from the uppermost valley settlement to Lebanon, 30 miles beyond, donated money and lands for the erection of a sawmill and a gristmill, and subscribed funds "for the encouraging of the preaching of the Gospel."

The efforts of the Lebanon proprietors proved successful. The pioneers of 1762 were joined in the following year by four families,

FIG. 2—Upland hay field. Early settlers moved only the medium-sized boulders: the small stones, it was believed, would add to the fertility of the soil and larger boulders were left undisturbed.

and during each of the next nine years about five families came to Lebanon. This steady inflow of settlers, which apparently continued until about 1790, was augmented by natural increase in the large families characteristic of the period, so that by 1790 the population of the town reached 1180.

A large number of the early comers pitched upon lands near the mouth of the Mascoma River (Pl. III).[2] Here, on relatively extensive intervales and terraces, they found lands that could be quickly subdued—flattish, stone-free areas with a friable soil and good drainage. As they were closely grouped and on the main track from the south, these settlers were saved the worst hardships of isolation. In addition, the clearings were handy to the first gristmill and the first sawmill, both of which were erected at power sites on the lower Mascoma.

Clearings were early established in the boulder-strewn uplands, however, on soils of superior fertility (Fig. 2). The agricultural

[2] Lists of persons known to have been in the town in 1767 and 1776, the recorded locations of some early settlements, and early road surveys were the principal materials used in compiling the maps. Surveys of most of the roads laid out in the town are recorded in the *Town Records* of Lebanon. The date, the starting point, compass directions, distances in rods, and the end are given for each survey. Hence it has been possible to plot and locate most of the more than 190 surveys made before the first published map of the town (1855). The brief description preceding each survey and the bounds contained in it, when correlated with published descriptions and a field investigation of the old roads and farm sites, have made it possible to plot most of the early settlements.

worth of soils selected by upland farmers was gauged by the vegetation. Nine classes of soils were thus commonly recognized, but that which was "generally esteemed the most easy and advantageous for cultivation" was the "warm, rich loamy soil" that supported beech and maple trees.[3] This superiority of beech and maple land helps to explain the early preference for the southern upland, for in this district beeches clearly predominated (Fig. 4).

FIG. 3—Beech-maple-hemlock woods in southeastern Lebanon. A climax forest of the type found by pioneers in Lebanon (compare Fig. 4).

A SUBSISTENCE FARM ECONOMY

Cleared lands won from the forest were quickly put to those uses that best promised the settlers a subsistence; isolation left no alternative. So marked was the subsistence level of early farming that supplies occasionally needed just north of Lebanon in the Dartmouth College community could not be obtained in the vicinity. In December, 1770, President Wheelock hesitated to enroll a newly arrived student, explaining to the latter's father that ". . . the great difficulty in taking your son at present is ye want of provisions in this starved country."[4] In the summer of 1774 a search "all around the Country [near Hanover] for Butter" proved futile, and during previous years wheat, flour, and butter were carried to the college from older settlements fifty, a hundred and more miles down the Connecticut.[5]

The cultural features of the changing landscape reflected subsistence farming. The average amount of land cleared for agricultural use on the 118 farms of twenty or more acres in 1789 was only fifteen

[3] Jeremy Belknap: The History of New-Hampshire, Vol. 3, Boston, 1792, pp. 128–130.
[4] Wheelock Collection, MS 770653.4, Dartmouth College Library, Hanover, N. H.
[5] *Ibid.*, MSS 773658, 773665, 774119.1, and 77406.3

and one-half acres. Within the following eleven years the cleared land per farm was nearly doubled (Fig. 5). The growth of population during these years was so rapid, however, that the amount of cropped land per person actually decreased and the acreage of mowing land and pasture land per person increased very little.[6] In addition to

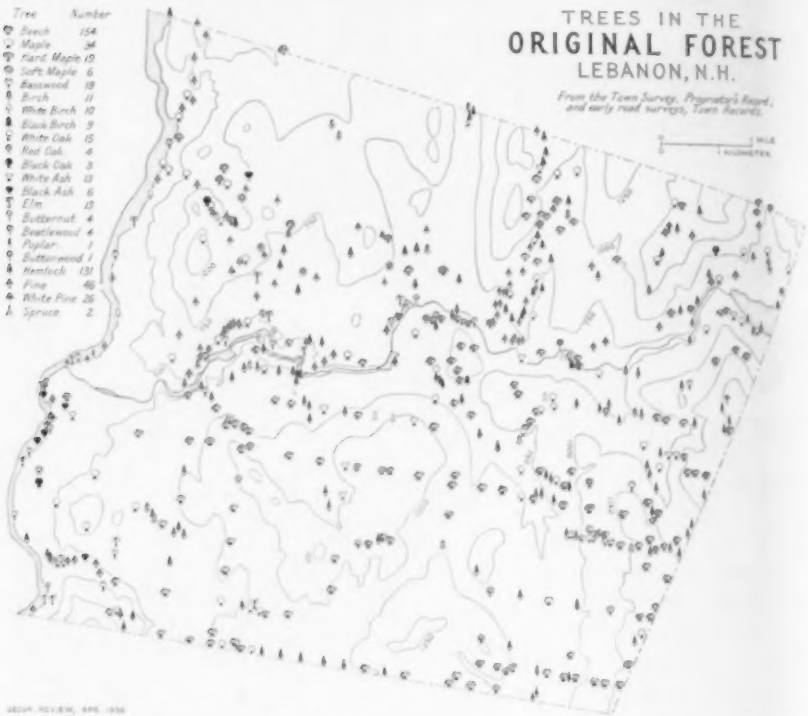


FIG. 4—A reconstruction of the original forest cover of Lebanon, from 531 trees named as bounds in the early surveys.

these improved lands, there evidently were even larger areas, used as pasturage for sheep and young cattle, from which much or all of the timber had been cut or burned.

Details of the landscape revealed the manner in which settlers

[6] The statistical materials that appear in the foregoing discussion and that were used in the construction of Figure 5 and other figures to be presented later were obtained from the *Invoice Records* in the Town Hall, Lebanon, N. H. The taxable estate of each person on April 1 was entered yearly in the *Invoice*. From the *Invoice* of 1787, the earliest one found, to that of 1833 the entries were very detailed, the items of interest to this study being polls; acreages in orchard, plowing, mowing, pasturing, and wild land; and the numbers of horses, oxen, and other cattle of various ages. Less complete entries in 1833 and later years have made it impossible to compute the total amounts of land in the various uses after that date.

The acreages of land in the different classes of utilization cannot be accepted as precise measurements; for the acreage estimates entered in the *Invoice* are in terms of productivity rather than in terms of areal extent. A tax act of June 12, 1784, defined an acre of orchard, for example, as so much "as will produce ten Barrels of Cyder or Perry, one year with another," and an acre of mowing as so much "as will produce one year with another one tun of english Hay or other Hay equivalent" (H. H. Metcalf, edit.: Laws of New Hampshire, Vol. 5, Concord, 1916, pp. 9–10).

were adjusting the farming practices of eastern Connecticut to their new forested holdings. The immediate needs of the Lebanon farmer were grain for his family and grass for his stock. A common way of meeting these needs was to sow a mixture of grass seed and winter wheat or rye on newly cutover lands. In the year following the grain

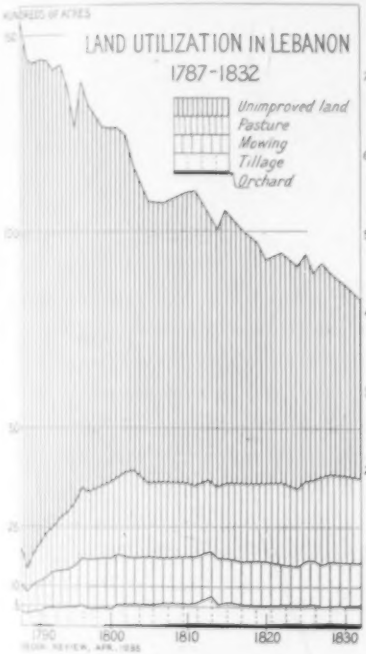


FIG. 5

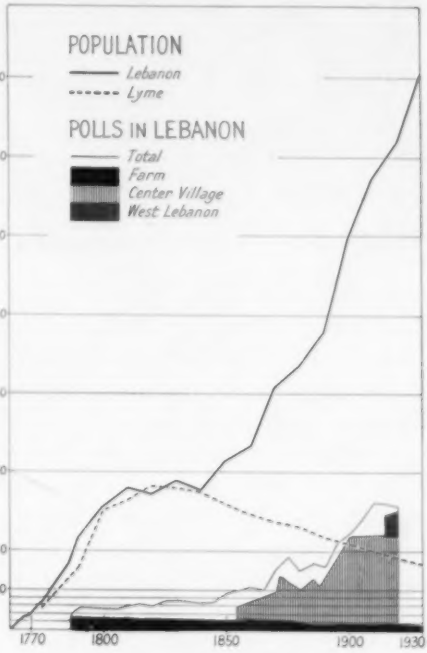


FIG. 6

FIG. 5—Graph showing the progress of land utilization in Lebanon from 1787 to 1832.

FIG. 6—Graph showing population and polls in Lebanon. The continued increase of population in Lebanon after 1840 is due to urban growth: the graph for Lyme, a neighboring town that remained rural, is added for comparison. This urban development is also indicated in the polls for the Center Village and West Lebanon precincts, as contrasted with the farm polls.

harvest the grass seed brought the land into hay or pasturage. Strict observance of this procedure meant that the tilled land of one year was being added to the mowed and pastured area of the following year. There came a stage in the development of each farm, however, when more grassland was not essential and when particularly suitable fields were tilled year after year. For the town as a whole that stage appears to have been reached about 1803 (Fig. 5). As fields were singled out for repeated cultivation a greater variety of crops undoubtedly appeared; for corn and barley gave heavier yields on old lands than on new, and it was said that flax, oats, and peas could not be raised "with any advantage" until the land had been cultivated "for some years."[7]

[7] Belknap, *op. cit.*, p. 136.

FIG. 7—The home of an early settler in Lebanon. The house was built on a terrace near the mouth of the Mascoma River before 1780.

By 1800 the pioneer stage was drawing to a close. Fenced-off tilled lands and mowings, pastured lands, farmsteads, and roads occupied conspicuous portions of the landscape. They by no means dominated it, however, for about four-fifths of the town bore a woodland cover of one sort or another. Frame houses and barns very probably had supplanted log buildings on all but the small and lately established clearings (Figs. 7 and 8). At five or more houses, scattered through the town, such articles as salt, sugar, molasses, tea, coffee, chocolate, and perhaps a few items of hardware were retailed. On the chief thoroughfares nine tavern keepers accommodated travelers. Three gristmills had been erected at power sites along the Mascoma, and there was a fourth on Sawmill Brook in the southwestern part of the town. Sawmills were in operation at the same sites or at others close by. At "several tanneries in different parts of the town" leather was produced for local use or for shipment down the Connecticut. The first school had been built in 1768; by 1775 settlement had spread enough to warrant the establishment of four school districts, and in 1784 the number of districts was doubled.

The road net of 1800 shows the first instance of the tendency for transportation to slip from hill to valley routes—a trend that even today is not ended. The way was now prepared for the growth of villages. The settlement of new areas and the construction of more and somewhat improved roads were making for the concentration of mills, stores, and other services at two strategic sites on the Mascoma. In 1800 the more important was Payne's Mills at the outlet of Mascoma Lake. The second village was taking form near the center of the town on a small plain that had become a focal site for all Lebanon in 1792 when the new Town Meeting House was erected there. Its continued growth has been a conspicuous feature of the town.

DIVERSIFIED COMMERCIAL AGRICULTURE ON A SMALL SCALE

The first three decades of the nineteenth century saw a transition from subsistence farming to commercial agriculture. Shipments to

FIG. 8—"Aaron Hibbard's new house," 1797. All early houses apparently stood in the open sun. The hackmatack trees before this house were not planted until about the middle of the nineteenth century, for they appear as mere saplings in an engraving of the house on a map of 1855.

temporarily enlarged markets overseas were facilitated by improvements permitting the unobstructed navigation of the Connecticut from Lebanon to the port of Hartford in 1802. Boat traffic, however, reached its peak about 1804 and declined steadily thereafter; the growing commerce was largely diverted over new and better land routes to new markets in the rapidly expanding industrial towns of southeastern New England.

Earlier there had been almost no traffic across the rough upland lying between the Connecticut and Merrimack valleys. The Governor's Road had been completed in 1772, but this roundabout, hilly route proved of little use for sleigh or cart traffic. Two proposals made later for the improvement of a wilderness track that crossed the low divide between the Mascoma and Smith rivers seem never to have progressed much beyond route surveys. Residents of Lebanon and Hanover had urged the improvement without success; but with the turn of the century they assured themselves of a market road by organizing the Fourth New Hampshire Turnpike Corporation. Nearly all the 400 shares of stock were purchased by people in Lebanon, Hanover, and Portsmouth.[8] With the locally obtained capital a good roadbed was constructed over the shortest proposed route between Lebanon and the middle Merrimack Valley. The completion of other turnpikes in New Hampshire and Vermont made Lebanon an important crossroads town, and the way was paved for further commercial and industrial development, as well as for agricultural advance.

Commercial agriculture was inaugurated by the production and shipment of a variety of farm products. Among the more important were flaxseed, linseed oil, pork and lard, salt beef, and wheat. The amount of wheat grown decreased, however, until, before 1840, it was not enough for home demands. Each autumn after 1800 from 200 to 500 fat cattle were driven from Lebanon, most of them to

[8] J. M. Shirley: The Fourth New Hampshire Turnpike, *Granite Monthly*, Vol. 4, 1880–1881, p. 229; J. W. Goldthwait: Six Old New Hampshire Turnpikes, *New Hampshire Highways*, Vol. 10, 1932, pp. 1–7 and 12–19.

Boston. The opening of good roads particularly stimulated shipment of butter and cheese. Between 1790 and 1810, although local demands for dairy products remained comparatively uniform, dairy herds were more than doubled in size. To convey these goods to market there developed those annual pilgrimages in farm sleighs that seem to have been welcomed by farmers as a holiday and social event, quite apart from any extra profit involved. When the traveling was good, box sleighs, drawn by a span of horses and laden with butter, cheese, pork, and poultry, were said to have "almost filled" the Fourth New Hampshire Turnpike and connecting roads from Montpelier to Boston.

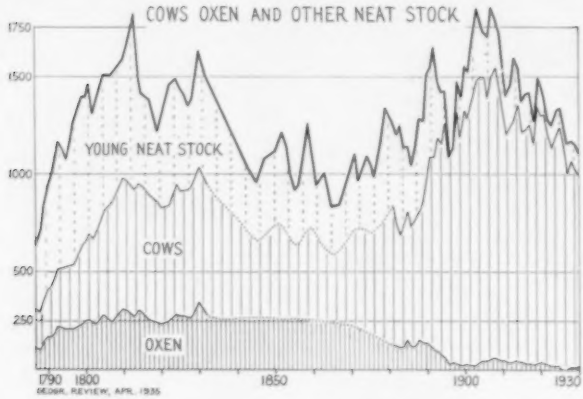


FIG. 9—Graph illustrating phases of cattle raising in Lebanon.

Larger shipments of animals and animal products were made possible, not by proportional extension of pastures, mowings, and grainfields, but by more intensive use of lands already improved. This took form in an accelerated turnover of livestock and in improvements in farm lands and practices. By adopting the policy of selling beef animals when less than two years old, instead of retaining them for another year or more, farmers after 1810 reared more cows and calves without increasing the total number of stock. Improvements in the land itself and in agricultural practices increased the productivity per acre. The removal of stumps and boulders increased the tillable area and provided materials for enclosing the fields. Where there were many boulders, the tendency was to wall in small fields long and narrow in shape. The small field was advocated as a means to increased production per acre:[9] by the shape effort was saved in removing the boulders. Careful use of manure, thorough plowing, and a judicious rotation of crops were urged through books, papers, and local societies concerned with farm management, and the stimulus of profitable markets may have hastened somewhat the slow adoption of these practices.

For the first time differences in the agricultural quality of lands became of crucial importance. Rather than remain on subsistence

[9] Samuel Deane: The New-England Farmer; or, Georgical Dictionary, Worcester, Mass., 1790, pp. 70, 205, and 206.

farms that could not be made to support a family on newer and higher standards, some farmers sold out and moved on, either to sparsely settled sections of northern New England or to the West. Neighboring farmers and a few people of wealth who were attracted to Lebanon purchased such farms and consolidated them with other holdings to make larger, more valuable units. Although a few large farms were divided among sons of the original settler, the process of consolidation was more general than that of division, and after 1800 the number of farms of 20 or more acres declined from the maximum of 132.

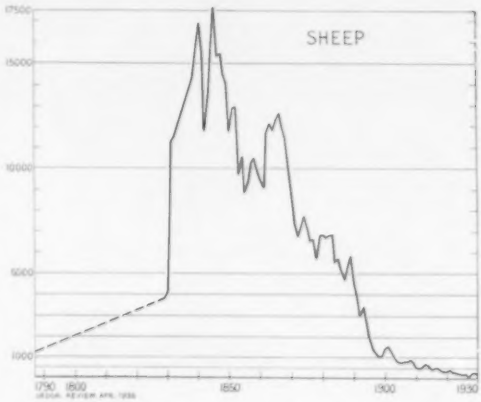


FIG. 10—Graph illustrating the rise and decline of sheep rearing in Lebanon.

The concentration of commercial, social, and manufacturing activities became more marked. An extension of manufacturing at Payne's Mills appears to have made that settlement the more important one until about 1840 and to have earned for it the name Lebanon City. A small cotton textile mill was being operated there as early as 1821, and about 1830 a larger mill was established in which about thirty people were employed in the manufacture of cotton and woolen textiles. Associated more closely with the farm community tributary to the "City" were the gristmill, the sawmill, the wool-carding and cloth-dressing establishment, the shop of a wheelwright and cabinet maker, and the blacksmith shop.

Although secondary to the "City" in manufacturing, Lebanon Plain rose to commercial and social leadership of the town. In addition to mills, stores, a meetinghouse, and two schools, the community boasted a Masonic Hall and a "social library" containing more than three hundred volumes. A hatter and a saddler brought the number of residents following a craft or a profession to a total of eleven. Two large taverns reflected the wider commercial importance that the village enjoyed as a turnpike crossing; so, too, did the pattern of the growing settlement, for the village clung to those axes that brought it life.

COMMERCIAL WOOL FARMING

A revolutionary change in agriculture took place in 1830—the expansion of commercial wool growing. The venture into sheep rearing on a large scale was precipitated by the heavy demands for

wool that arose as domestic woolen manufacturers increased their output under protection of the tariff of 1828. Stimulated by the high prices, farmers in Lebanon doubled and redoubled their flocks between 1830 and 1840, adding more than 13,000 animals to the number of sheep within the town. The premium on fine grades encouraged farmers to improve the quality of wool by crossing their "common

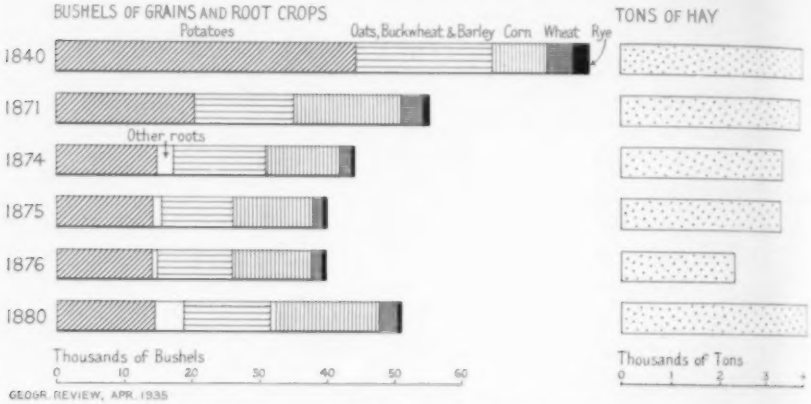


FIG. 11—Graph of the crop production of Lebanon, 1840 to 1880. Data for 1840 is from the U. S. Census, for succeeding years from the annual reports of the New Hampshire Board of Agriculture.

sheep" with the few Spanish and Saxony Merinos that had been brought to Lebanon during the earlier, but locally unimportant, Merino "craze" of 1807–1816.

The new sheep industry seriously taxed the agricultural resources of the town; for evidently until farmers felt reasonably sure that sheep rearing had a promising future they made no proportional reduction in the numbers of other stock. As early as 1832 the demands upon lands producing grain and forage crops were fully 60 per cent greater than they had been, on the average, during the period from 1800 to 1830. The production of more stock feed was imperative. By 1840 as much as 90 per cent of the cultivated land had probably been turned to the production of crops for the support of stock; hay alone occupied 70 per cent of the cultivated area. Considerable amounts of buckwheat were then being grown, since this plant yielded stock feed on "weedy and waste lands" and at the same time prepared these lands for more valuable crops. The cultivated area was increased by this means and also by elimination of the summer fallow; but in the absence of adequate schemes of rotation soil fertility declined. This, in turn, led to belated improvements.[10]

Great as was the demand upon cropped land, more was exacted from pasture land. Estimates of that time seem to indicate that the

[10] In 1852 it was reported from Rutland, Vt., that "many now plough deep and give thorough culture, and begin to understand that the greatest support upon which they can depend is their manure" (*Ann. Rept. U. S. Patent Office, 1852*, Washington, 1853, Part 2, p. 134).

addition of every sheep placed nearly twice the demands upon pasturage as upon tilled lands. Furthermore, lambs required summer pasturage but not winter forage, since they were dropped in the spring and disposed of in the autumn.[11] Pasture requirements probably were increased more than 200 per cent above the earlier level, and this upset the apparently nice balance between numbers of stock and pasture capacity that had been maintained from 1800 to 1830. Although at first the intensive grazing doubtless seemed beneficial to bushy pastures, continued overstocking reduced the quantity of forage grasses and lowered their quality. A farmer in Hanover estimated in 1855 that "in the best season . . . not more than three quarters as much stock can be supported at pasture as ten years ago."[12]

The boom period of sheep rearing came to a close about 1845, and two readjustments in the industry followed. The first was marked by a very abrupt decline in the number of sheep and by a compensating rise in the weight of fleeces.[13] The change was a matter of necessity; for farm lands were less productive, the estimated costs of maintaining a sheep had increased more than 30 per cent,[14] and wool prices were lower. This first readjustment appears to have been completed in about ten years, and, aided by slightly higher prices, the wool industry entered upon a period of stabilization in 1855. Stabilization was terminated by a revival during the Civil War, when exceptionally high prices for coarse wools again made sheep rearing profitable on all farms.

The landscape gained a decidedly pastoral aspect during this era of wool growing. By 1855 the area of woodland had been reduced to less than one-fifth of the town. The land in crops, three-quarters of which was given to fields of timothy and clover, was slightly greater than the wooded area. The continued extension of pasture land at the expense of woodland was attended by an interesting change in outlook toward trees. A shade-tree movement that resulted in the planting of sugar maples, elms, locusts, and hackmatacks along roadways and in farmyards gained considerable headway by 1860. In the annual town meeting of 1861 it was resolved " 'that the inhabitants of the town be allowed to set out shade trees and make sidewalks on the sides of the streets,' "[15] and by 1871 there were at least two nursery-

[11] These lambs were not taxed and so did not appear in the *Invoice*. Consequently the pastures of Lebanon in reality were supporting between 50 and 100 per cent more sheep than are recorded in Figure 10.

[12] *Trans. New Hampshire State Agric. Soc., 1855*, Concord, 1856, p. 282.

[13] The average weight of Merino fleeces in New Hampshire increased from two pounds six ounces in 1840 to four pounds in 1856 (E. A. Carman, H. A. Heath, and John Minto: Special Report on the History and Present Condition of the Sheep Industry of the United States, U. S. Bureau of Animal Industry, Washington, 1892, p. 331).

[14] *Ann. Rept. U. S. Patent Office, 1849*, Part 2, pp. 86 and 242; *1850*, Part 2, p. 335; *1852*, Part 2, p. 146; and "Is Wool Growing Profitable at the North," *Granite State Whig*, Lebanon, N. H., Apr. 29, 1859.

[15] C. A. Downs: History of Lebanon, N. H., 1761–1887, Concord, N. H., 1908, p. 294.

men in the town. With great effort the pioneer had chopped his sunny homesite from a hostile forest, but in 1855 a farmer in Hanover "feared" that another season would "see the axe in more active operation." The ax was no longer the symbol of liberation: trees had become valuable assets.

Urban Growth and Rural Decline

A marked shift in population, characteristic of New England as a whole, was under way in Lebanon by 1850. A rapid growth of urban population and a slow decline in rural population had set in.

The sudden and sustained increase in the population of the town after 1840 was due solely to an expansion of urban centers (Fig. 6); for the trend in rural population was downward, like that in neighboring towns in which no large villages grew up.[16] The data for Lyme, for example, show the trend in a town similar in agricultural resources but lacking the conditions that made for urban development in Lebanon.

The decline in rural population was reflected in abandoned farmsteads, most of them in areas of steep slopes and thin soils, where crop production had become unprofitable. By 1860 there appear to have been at least thirty fewer farmhouses or house sites occupied than there had been about 1830, and by 1892 the number in disuse had risen to fifty-two (Pl. III). These losses, however, do not represent the abandonment of a proportional amount of improved land. In most cases deserted lands seem to have been added to the hay lands and pastures of farmers who remained. Consequently, after the sheep industry passed the peak of 1845 there probably began an abandonment of houses and an enlargement of landholdings somewhat like that which had occurred in the early part of the century. There seems, however, to have been this difference: the earlier enlargement of holdings resulted, in large part, from the aggressive action of optimistic purchasers, whereas the later one was merely incidental to the abandonment of farms by discouraged owners.

This downward trend in rural population was accompanied by a rapid growth of villages. An era of urban expansion was opened in 1848 by the completion of the Northern Railroad between Concord, N. H., and Lebanon. Regular employment at the terminus of the road in western Lebanon and at the railroad junction just across the Connecticut furthered village growth (Pl. III), but of far greater importance was the establishment of new manufacturing enterprises. Before the construction of the railroad costly transportation had

[16] See the series of maps of "Population Trends by Townships in New Hampshire & Vermont, 1790–1930" accompanying H. F. Wilson: Population Trends in Northwestern New England, 1790–1930, *Geogr. Rev.*, Vol. 24, 1934, pp. 272–277. See also the same: Population Trends in North-Western New England, 1790–1930, *New England Quarterly*, Vol. 7, 1934, pp. 276–306.

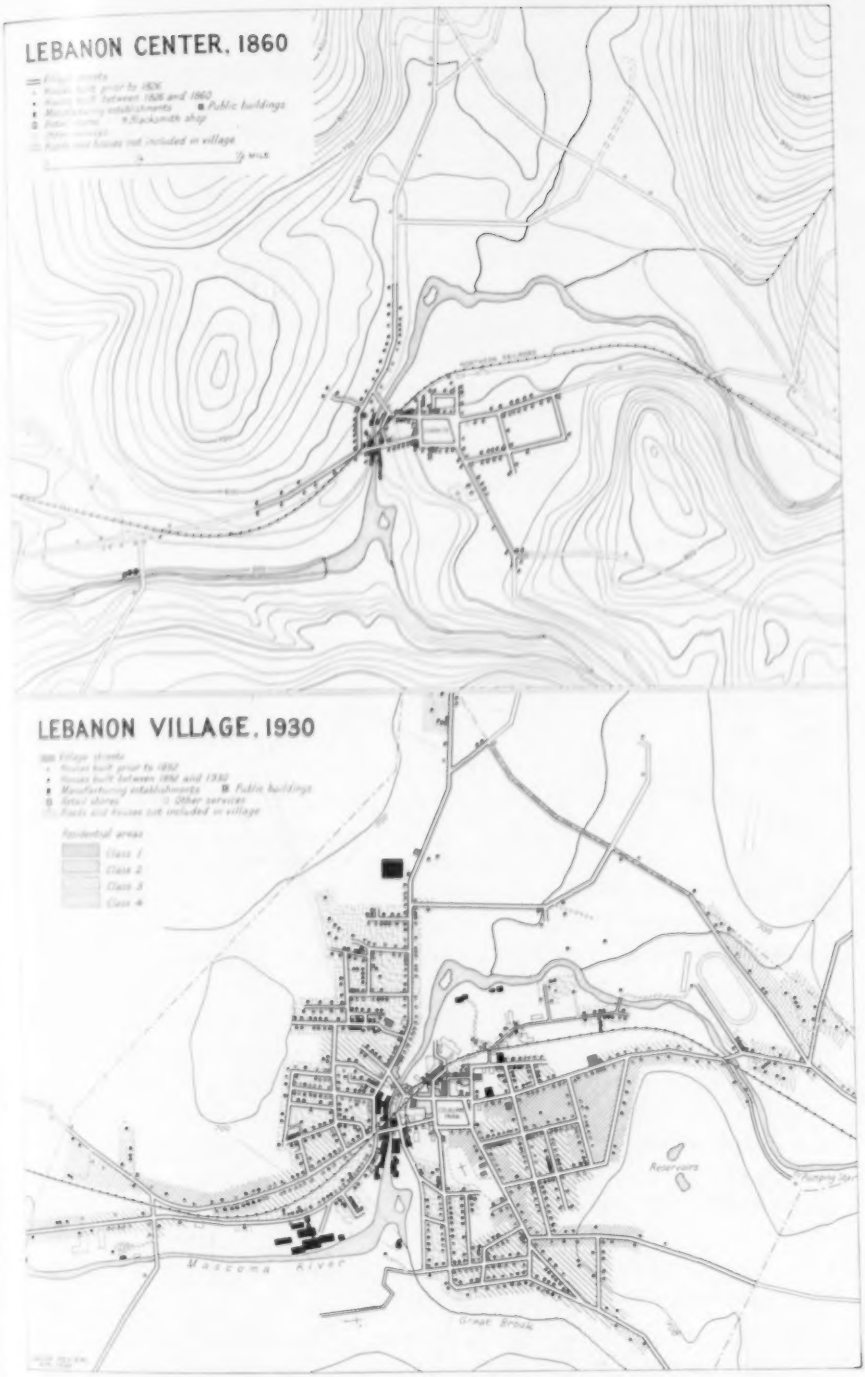


FIG. 12—Maps illustrating two stages in the development of Lebanon's chief center. On the map for 1860, roads, streets, and buildings are from H. E. Walling's "Topographical Map of Grafton County," 1860. Contour interval on the map for 1860 is 200 feet; on the map for 1930 the 700-foot contour only is shown. Maps of Lebanon Village for 1826 and 1892 have also been prepared and similar maps for West Lebanon–White River Junction in 1855 and 1930.

hampered the development of manufacturing and doubtless had contributed to the failure of the early textile industries in Lebanon, all of which had been abandoned by 1841. In 1844 carriage by farm sleigh from Lebanon to the northern terminus of the railroad at Concord cost $10.00 a ton.[17] Four years later the Northern Railroad advertised rates from Lebanon to Boston—more than twice the distance to Concord—of $5.80 a ton for first-class freight and $4.80 for second-class freight.[18]

Most of the new industries were established at the village near the center of the town. It acquired a new name, Lebanon Center, after the new village of West Lebanon was founded at the terminus of the railroad. The Center, indeed, had gained the leadership in 1840 when a fire destroyed all the mills at the eastern village, Lebanon City, whose pretentious title fell into disuse and was replaced by East Lebanon.

The expansion at Lebanon Center was based on superior water-power resources together with availability of railroad transportation. The operation of gristmills, sawmills, and other small-scale manufacturing plants had required little power, had not been greatly hampered by shutdowns, and had proved successful in Lebanon and elsewhere at sites where only small and fluctuating amounts of power could be obtained. Power in considerable amounts and of dependable character was, however, prerequisite to the establishment of larger factories, and power of this description was available from the Mascoma at Lebanon Center. The river has a comparatively uniform flow because of the storage afforded by the many lakes and marshes in the large, flattish basin behind Moose and Shaker mountains. The location was much more satisfactory for industrial development than the earlier manufacturing village in eastern Lebanon. At and below the latter, power sites are strung along the narrow, steep-walled gorge, where there is little or no available land for village growth, whereas at the Center good, closely spaced power sites are adjacent to large areas of flattish or moderately sloping lands.

At this favored center three overlapping stages of industrial development may be recognized after 1848. The first was dominated by industries using iron, the second by wood-using industries, and the third by textile manufacture.

The industries first established at the Center turned out a remarkable variety of products, the more important of which required considerable quantities of iron. Capitalists at first seem to have anticipated the profitable production in the village of many, if indeed not all, of the manufactured articles needed in the tributary country-

[17] Professor C. B. Haddock of Dartmouth College gave the rate as fifty cents per hundred in his "Address Before the Railroad Convention at Montpelier, Vermont, 1844" (in his "Addresses and Miscellaneous Writings," Cambridge, Mass., 1846, p. 109).

[18] *Granite State Whig*, July 7, 1848.

side. One plant, the pride of the village in 1855, was producing mill irons, portable and stationary steam engines, planing and mortising machines, mowing machines, sewing machines, brick machines, nail machines, nails, shoe pegs, and other articles.

Remote from sources of iron and from coal with which to work it, Lebanon was poorly situated for continuance of the several industries requiring large quantities of these materials, and marked readjustments took place. The first change was toward specialization in fewer articles. At one machine shop in 1873 attention was centered on the production of woodworking machinery, at another on water wheels and circular sawmills; and at the Granite Agricultural Works 550 mowing machines were manufactured annually. Furniture, patented drag rakes, organs, and patented dustproof watch keys were new specialties established before 1877. This trend was followed by the elimination of all heavier metal industries except the foundries and machine shops essential to a factory center. By 1887 the only important metal-using industries were the rake factory, the watch-key shop, a foundry, and two machine shops, and not long after that one machine shop and the rake factory ceased operations.

Despite the rise and fall of ill-adjusted industries, activity at the Center seems to have advanced to successively higher levels. The village continued to grow and to show a more marked orientation to the mill section. As attractions for industry there were added to the excellent power resources a growing supply of labor and a policy of exempting new capital investments in industry from town taxation for a period of ten years. The industrial vitality of the site was amply demonstrated after the fire of 1887, which destroyed all the mills in the central section, laying waste 80 buildings on an area variously estimated to be from eight to twelve acres in extent and throwing 600 men out of employment. Recovery was so speedy that neither the population record (Fig. 6) nor the map of 1892 (not included here) gives any indication of the catastrophe.

The roster of industries after the fire, however, showed marked changes. The furniture business had incurred heavy losses for a number of years, partly because of inability to market profitably a greatly increased output, into much of which went black walnut, chestnut, and other woods not available in the vicinity. The leading position passed to a new group of industries. A start on this line of development had been made shortly before the fire with the establishment of two woolen mills and two garment factories. These four enterprises employed about 250 people in 1886. Only one of the mills had been destroyed by the fire. This had been promptly rebuilt, and to the group of four a knitting mill and another woolen mill were added. The growth of this group of industries seems to have been forwarded by labor advantages as well as by adequate power. At the time the

new mills were erected the women of the community constituted a large and unexploited supply of labor. The textile-mill owners also found of advantage the soft water from the crystalline rock basin of the Mascoma. This is admirably suited, without treatment, for bleaching and dyeing processes. Furthermore, the power advantages were increased; for the addition of controlled storage capacity behind dams upstream—a capacity that today has been enlarged to 1354 million cubic feet—permitted regulation of the flow.

Agricultural Readjustments

In agriculture, two changes occurred between 1867 and 1910. The great sheep-raising period was followed by twenty years of experimentation, of fumbling for a new and more profitable branch of agriculture. Cattle rearing, wool growing, a combination of the two, the rearing of horses, grain farming, fruit culture—each had its advocate in 1871.[19] The general trend was from sheep to cattle; but the changes were not sudden except for the marked decline in sheep rearing that took place when the unusually high prices for wool that had prevailed during the Civil War dropped to prewar levels. This sudden slump in sheep rearing was followed by more than a decade of relative stability; for a large number of Lebanon farmers, in the absence of an alternative proved more profitable, clung to the production of thoroughbred Merinos.

Many of the farmers who sought in cattle rearing a more profitable activity than wool growing turned their attention to dual-purpose animals. Durham bulls were introduced, and considerable progress seems to have been made in the production of superior beef animals without great sacrifice of dairy qualities. The farmer now found increasingly greater demands for beef and for dairy products in the growing villages, in addition to markets in southeastern New England. Beef production increased from 58,000 pounds in 1874 to 79,500 pounds in 1880; the annual production of butter was about 35,000 pounds.

The period of experimentation terminated in the establishment of two creameries, one at Lebanon Center in 1886 and the other at West Lebanon before 1888. Sheepmen speedily disposed of their flocks; dual-purpose animals went out of vogue and Jerseys became favorites as the efforts of most farmers were turned to the production of butterfat now in demand at the new creameries. In the evident readiness of sheep owners to abandon wool growing when this promising alternative arose is the recognition of their inability to compete with the wool industry that had been growing by leaps and bounds in the West, where the cost of wintering animals was lower.[20] Further-

[19] *First Ann. Rept. New Hampshire Board of Agriculture*, 1871, p. 98.

[20] In 1873 nearly three-fourths of the annual cost of maintaining a sheep in Lebanon were assigned to winter forage in an itemized estimate presented to the Lebanon Agricultural and Mechanics Association and printed in the *Granite State Free Press*, Lebanon, N. H., Feb. 13, 1873.

more, the revenue derived from the sale of heavily wooled, northern Merinos in the South and West declined as the price of coarse wool came to equal, and then to exceed, that of fine wool. Merinos are said to have disappeared from Lebanon by 1890, and the very few farmers who continued to raise sheep turned to the rearing of mutton types.

The quick decline in sheep rearing was accompanied by an equally

FIG. 13—White pine woods in old field in the saddle west of Pinnacle, southeastern Lebanon.

rapid growth of the dairy industry.[21] During the eight years after 1886 the number of cows was almost doubled, and by 1908 there were more than twice as many cows in Lebanon as there ever had been before this expansion. The creameries took most of the additional milk produced, but domestic buttermaking was not displaced. As early as 1888, however, the butter made at the creamery at West Lebanon alone (66,680 pounds) was more than twice that produced on farms.

The farmer was now confronted with the problem of obtaining the maximum amount of butterfat from his herd. New forage crops, such as ensilage corn and oat hay, were essential. The production of ensilage in Lebanon increased from 350 tons in 1888 to 2870 tons in 1898, and for its storage 25 silos had been added to the equipment of farmsteads. As the limited amount of good tillage land was used to an increasing extent for improved fodder crops that could not economically be brought to Lebanon, grain production dropped rapidly: dependence came to be placed on western grain and stock feeds.[22]

[21] Compare the growth of the dairy industry in Windsor, Vt., in H. F. Wilson: The Roads of Windsor, *Geogr. Rev.*, Vol. 21, 1931, pp. 379–397.

[22] In 1913 the outlay for grain ($1000) on one of the better dairy farms about forty miles north of Lebanon amounted to 43 per cent of all farm expenses (F. E. Robertson and L. G. Dodge: Some Profitable and Unprofitable Farms in New Hampshire, *U. S. Bur. of Plant Industry Circular 128*, 1913, p. 10).

FIG. 14—Upstream from the lower end of the rapids, Lebanon Village. On the left are a shoddy mill, a foundry and machine shop, a split-ball-bearing factory, and a knitting mill. In the foreground on the right is a woolen mill.

The deterioration of pasture lands, recognized as early as 1845, continued rapidly. The decline in carrying capacity appears to have been hastened by the change from sheep raising to dairying and by consequent undergrazing—not by overgrazing, as was the case earlier. Not only did cattle fertilize pastures less thoroughly than sheep, but they also cropped less closely and were not so willing to forage upon woody growth. Consequently more and more trees established themselves in the pastures, and grass was shaded out. The forest steadily encroached on the cleared lands of the town. As early as 1873 it was reported from Lebanon that the area of woodland was increasing. The type of woodland evidently was related to the intensity with which the land was grazed. Two extreme types may be noted, between which there were many variations. On lands where enough stock were pastured to crop back and to prevent the growth of all seedlings except the unpalatable conifers, bushy white pine gained a roothold (Fig. 13). In this manner pure stands of white pine have come to occupy conspicuous portions of the upland where pioneer settlers found only a few of these trees scattered through a deciduous forest. At the other extreme, on lands either completely abandoned or grazed but little, poplar and gray birch quickly established themselves. Woodland made inroads, too, on some hay lands—along walls, on steep inclines, and

FIG. 15—Downstream along the east bank from the lower bridge, Lebanon Village. In the foreground, a woolen mill, beyond it, the "key shop." Power is obtained from turbo-electric generator units of 200 H.P. or less and, in the case of the textile mills, from auxiliary steam plants, which generate heat needed in processing the fabrics.

close to large boulders where it proved difficult to mow with a machine. As a result of this varied and persistent encroachment of the forest the general appearance of the countryside has grown more and more to resemble that of the early years of the preceding century.

Present-day Use of Land: Urban Conditions

Present-day land use in urban and rural areas alike is a continuation of earlier trends. The rural areas, with a greatly diminished population, present the incongruous combination of modern dairy farms in a setting somewhat like that of 1790. The urban centers, which contain more than 80 per cent of the residents of the town, are more populous than ever before. The village of Lebanon, as the Center has come to be known, remains the chief industrial center and has a population of about 4700. West Lebanon, with about 1300 people, is functionally part of a larger railroad and wholesale distributing center, the nucleus of which lies across the Connecticut in White River Junction, Vermont. East Lebanon, with less than twenty houses, has become rural.

The industrial activities upon which the present importance of Lebanon Village rests are much the same as those established by 1892. The manufacture of textiles ranks first with a predepression employment of about 1200 of the total 1700 industrial workers. Clothing, wood products, brick, and specialized metal goods, however, are of importance. The type of metal-using industry that has been able to survive, not only in Lebanon but also in New England as a whole, is exemplified in the business at the "watch key shop," where from 50 to 200 workers are employed. The production of dustproof watch keys upon which the business was founded in 1876 still continues, but new and more important articles have been added. These include watchmakers' tools and small electrical goods such as motors, generators, phonograph drives, and toy shocking coils. The local supply of skilled labor is of prime importance, for the costs of raw materials and transportation are relatively small. Such compact, valuable articles are in marked contrast with the bulky engines and machinery turned out by the early and unsuccessful metal industries in Lebanon.

The chief manufacturing district remains along the banks of the rapids near the center of the village (Figs. 12, 14, and 15). Below the main factory district are the Mascoma Mill of the American Woolen Company and, farther downstream, a 350-horsepower unit of the Grafton County Electric Light and Power Company, which has another plant of equal capacity still farther downstream and a third with a capacity of 24,000 horsepower at the mouth of the Mascoma.

Away from the power seats, at the northern edge of the plain and on the low intervale beyond, are industries requiring less power or

FIG. 16—View south across Colburn Park, Lebanon Village.

greater space. Here are the two clothing factories noted earlier, an electrically driven sawmill, a bobbin mill, and storage yards for building materials and coal. At an excellent surface deposit of clay near the northern edge of the village is a brickyard where about five million bricks are produced in the six or seven warmer months during which it can be operated.

Beyond the eastern border of the built-up village an excelsior mill was constructed in 1903 at an easily developed power site adjacent to railroad, to hard-surfaced road, and to ample flattish land for storing the short logs used. The establishment of this mill is directly related to the abandonment of farms and the less intensive use of pastures; for poplars, those pioneers on abandoned lands, furnish at least 90 per cent of the 6000 cords of wood consumed annually.

New features of the village landscape are the residential areas, largely peopled by millworkers, on the slope west of the central mill district and on the terrace southeast of it. Inferior residential districts, composed of small, lightly constructed buildings, some of them mere shanties, have sprung up on cheaper lands beyond the limits of the thickly built-up village. The fine old houses built along or close to the turnpikes in the early nineteenth century (Figs. 16 and 17) have aided in maintaining on these streets, and on the plain as a whole, residential areas of more restricted character.

FIG. 17—View west along the northern edge of Colburn Park, Lebanon Village.

RURAL LAND USE

In the rural districts dairying has grown to be the chief, and virtually the only, agricultural inter-

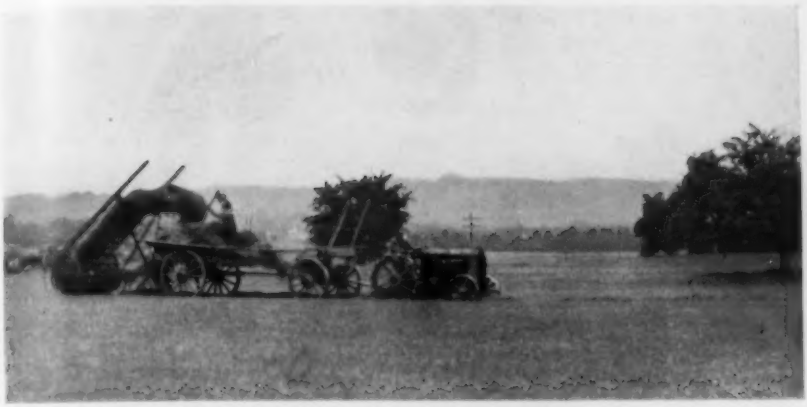


FIG. 18—Haying in large field on alluvial lands, Great Hollow.

est of all farmers except one who still relies on sheep. The industry has undergone only minor changes, and these were largely caused by the closing of the local creameries about twenty-five years ago. The production of market milk rather than cream is now the objective of most dairymen. The change has been accompanied by a preference for cattle that produce the maximum quantity of milk—Holsteins and Ayrshires—and by the rearing of fewer hogs and calves, since there now is little skim milk available for these animals. Also, local outlets for dairy products have become of somewhat greater importance than outside markets. Almost half of the farmers who sell whole milk market it in the villages; the remainder sell either to a coöperative creamery at Bellows Falls, Vt., or to Boston. Cream, chiefly for sale in Arlington, Mass., or butter, entirely for sale in the villages, is still produced by about one-quarter of the farmers, most of whom either combine other work with farming or are relatively isolated.

The remaining improved lands are set in a rising sea of woodland (Pl. III). Some of the woodland is used for pasture; some of it yields saw timber, bobbin stock, firewood, and material for the excelsior mill; but much of it is of little value at pre-

FIG. 19—Tiny hayfield in southwestern Lebanon.

sent. It is chiefly on drier hilltops and on warm, south-facing slopes that grasses have held their ground against the advancing forest. Choked with trees and unnutritious plants such as hardhack, pastures do not yield adequate amounts of summer forage. To supplement scanty pasturage, a few farmers are experimenting with planted pastures of sweet clover, and many more give a small portion of their tilled land to millet or soybeans, which are fed as green fodder during the summer. Large amounts of purchased grain, however, must be fed during both summer and winter. Other forage crops such as ensilage corn and oat hay are grown; but, as has been the case since the beginning of the last century, timothy and clover hay occupies much the greater part of the cultivated land.

As regards their use of the land, the residents of the rural areas may be divided into four groups ranging from full-time farmers to people who do not work the land and are mostly employed in the villages. The widely scattered places at which farming is the only occupation comprise about 30 per cent of the rural residences and include the better farms. The latter are marked by good tillage lands, easy access to hard-surfaced roads, and the expenditure of considerable amounts of labor on the land in the past. The last is of peculiar importance in the uplands; for farm implements can be used efficiently only on extensive tracts that have been cleared of large boulders.

About as many houses are occupied by people who do no farming as by the full-time farmers, but they show a more marked localization along the hard-surfaced and improved roads. The amount of land owned ranges from small patches supporting a shack and a garden to large farms of 200 or more acres. A cow is maintained on some places, but with few exceptions tillage is limited to a garden. With good fortune the owner may be able to rent his pasture land and sell his standing hay. In most cases, however, there is no manure available for hay lands, and without it the crop so deteriorates within a few years that farmers will not trouble to cut and cure the hay if it is given to them, let alone pay for it. Trees come in, and the hayfield is presently obliterated.

Between these two extreme types of rural dwellers are some for whom farming is secondary to regular work in the villages and some for whom farming is the main occupation but who are also more or less regularly engaged in activities not related to the farm. The combination of farming with other occupations is much like that which existed in the early days of subsistence agriculture. In earlier times, however, it was the professional men who combined agriculture and other work; now it is largely the millworkers. The combination of town and country is one of the chief assets of Lebanon. As the young manager of a new industry remarked to the writer, "It is a good place to live."

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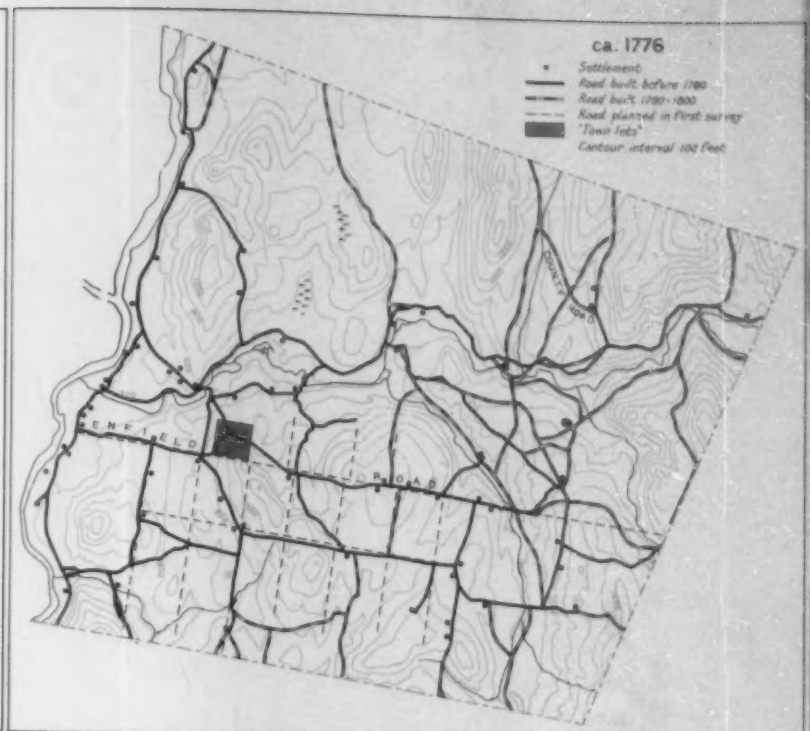

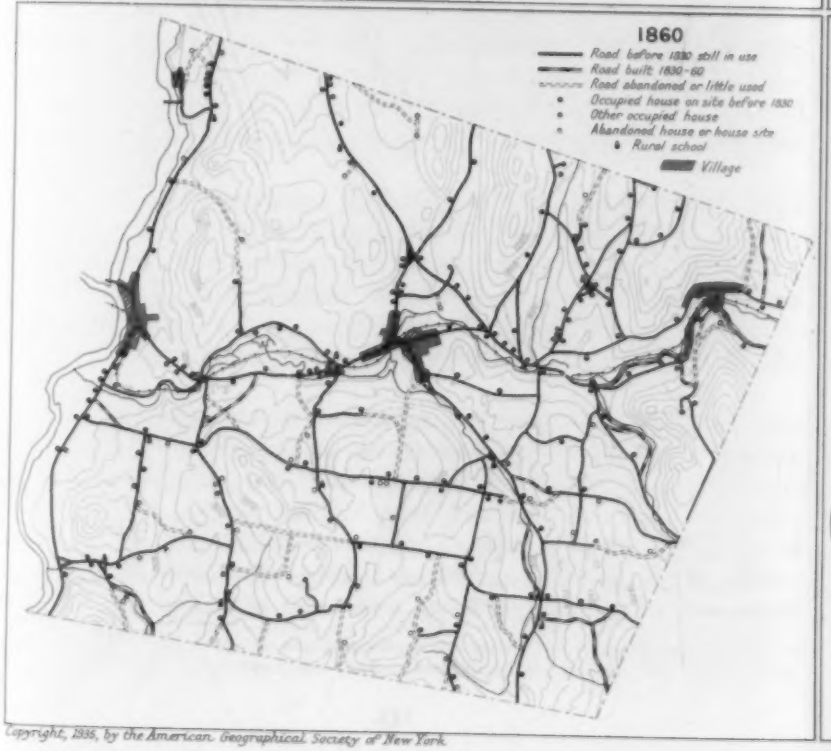

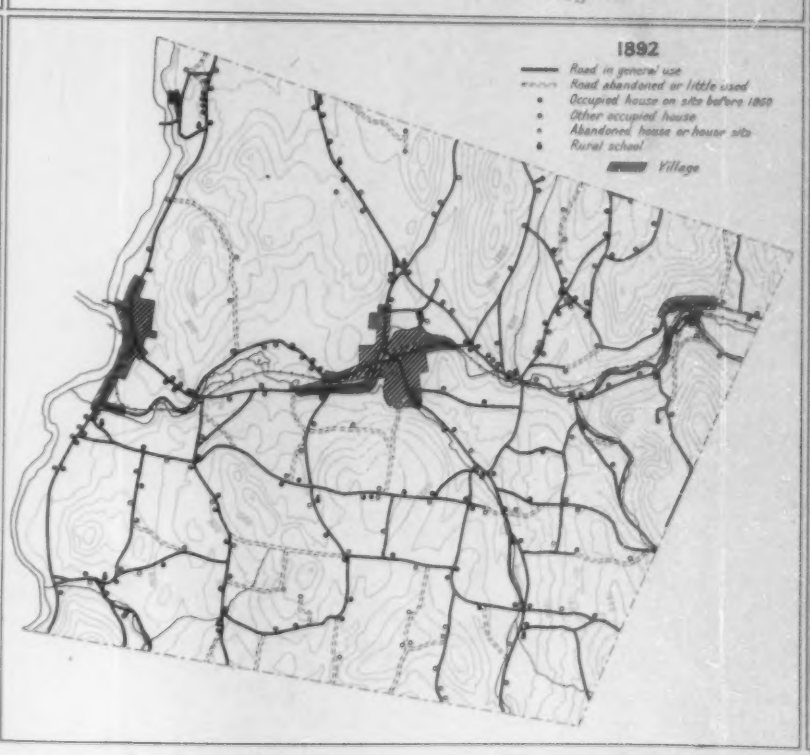

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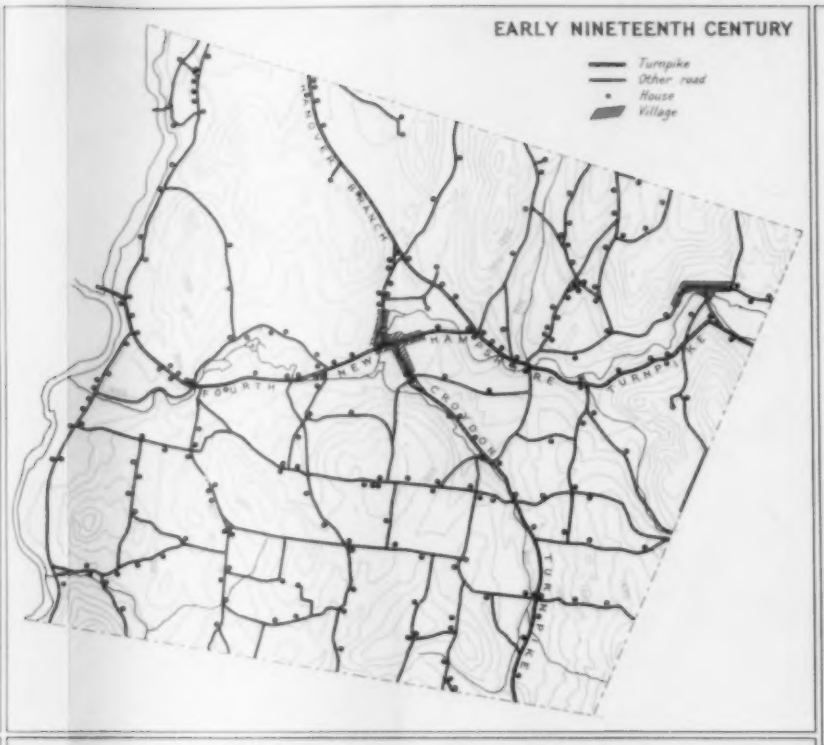
EARLY NINETEENTH CENTURY
Turnpike
Other road
House
Village
NORTH BRANCH
FOURTH
NEW
HARTFORD
TURNPIKE
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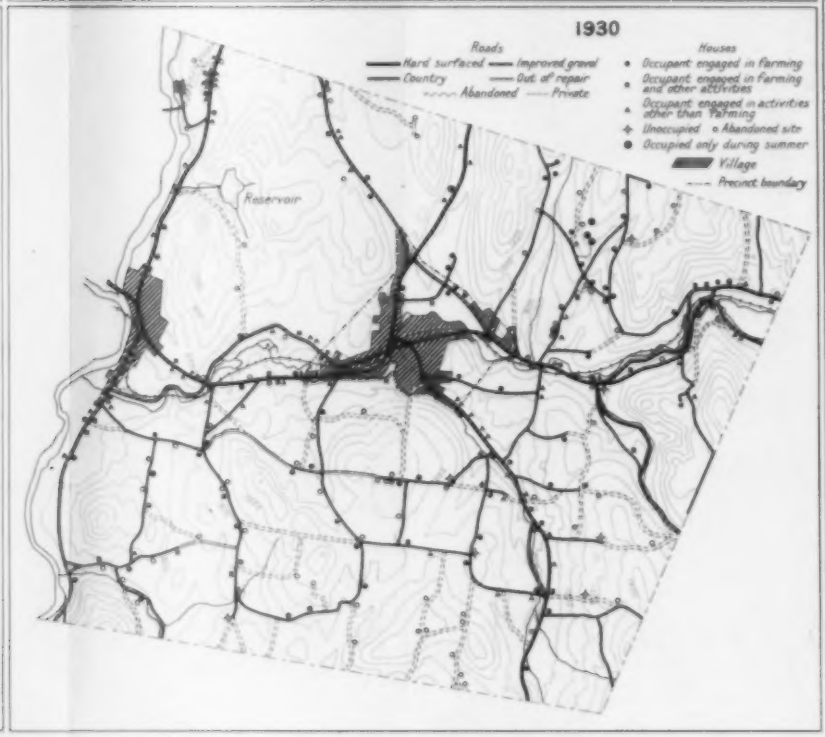
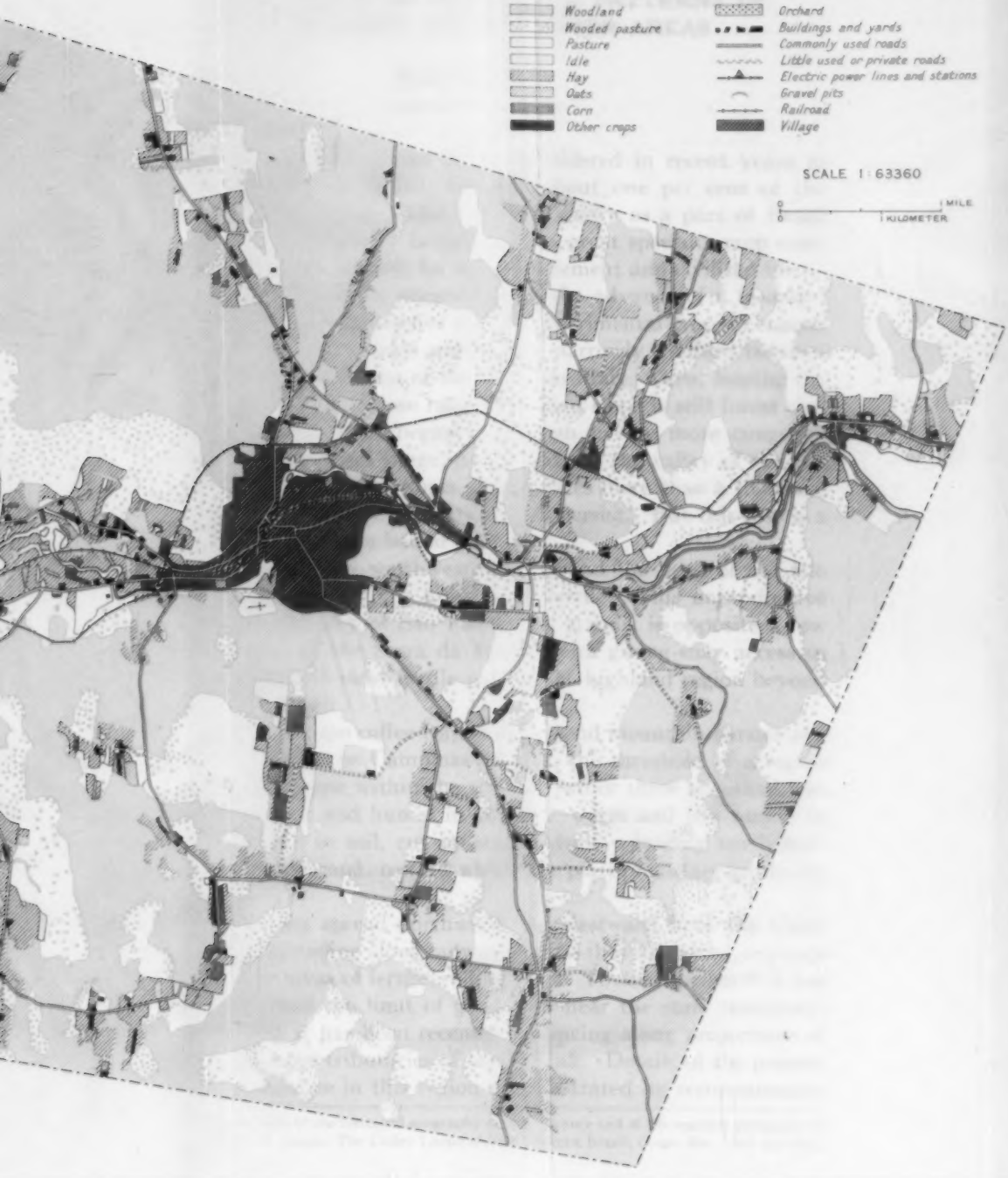
THIRD


1930
Roads
Hard surfaced
Improved gravel
Country
Out of repair
Abandoned
Private
Houses
Occupant engaged in farming
Occupant engaged in farming and other activities
Occupant engaged in activities other than farming
Unoccupied
Abandoned site
Occupied only during summer
Village
Precinct boundary
Reservoir

LAND UTILIZATION IN LEBANON, N.H. 1930



UNIV. OF MICH.

COFFEE PLANTATIONS OF BRAZIL

A COMPARISON OF OCCUPANCE PATTERNS IN ESTABLISHED AND FRONTIER AREAS

Robert S. Platt
University of Chicago

THE coffee region of São Paulo, considered in recent years to be the heart of Brazil, occupies about one per cent of the area of the nation. This region is known as a part of Brazil where conditions peculiarly favorable for a great specialty crop coincide with conditions suitable for white settlement and civilized life.

The form of the coffee region reflects the advance of a frontier.[1] A century and a half ago coffee was an experimental crop on coastal lowlands near Rio de Janeiro and Santos, narrowly confined between the sea and the escarpment of the Serra do Mar. Then, leaping the first mountain barrier, whose rugged seaward slope is still forest clad and unproductive, coffee began to flourish in the more congenial trough back of the coast range, particularly in the valley of the Rio Parahyba, where there are slopes and terraces more than a thousand feet above the sea. Here plantations still persist. But this also is a narrow strip of mountain-bound land.

The trough extends southwestward beyond the head of the Rio Parahyba, though here it is hilly and infertile. This unproductive section, where the city of São Paulo now stands, is opposite a low and narrow part of the Serra da Mantiqueira giving easy access to the least rugged and most fertile part of the highland region beyond the mountain ranges.

Here a century ago coffee leaped the second mountain barrier and established itself in the Campinas district, the threshold of a region of rolling uplands just within the tropics, two or three thousand feet above the sea, hot and humid in summer, warm and less humid in winter, diversified in soil, cut by stream valleys leading northwestward to the Rio Paraná, toward which the plateau surface gradually descends.

Coffee planting spread northward and westward from the Campinas district, extending along railway lines as they advanced, expanding in favorable areas of fertile, rolling land. Toward the north it has practically reached the limit of good land near the state boundary; toward the west it has been recently advancing along projections of the upland between tributaries of the Paraná. Details of the present pattern of occupance in this region are illustrated by reconnaissance

[1] For a presentation of the historical geography of this advance and of the regional geography of the industry see P. E. James: The Coffee Lands of Southeastern Brazil, *Geogr. Rev.*, Vol. 22, 1932, pp. 225–244.

studies of plantations in two areas—at the old threshold of the region in the Campinas district and on the new frontier in the Marilia district.

Campinas District

The Fazenda Chapadão is typical of the Campinas district, though somewhat larger than the average plantation and somewhat better

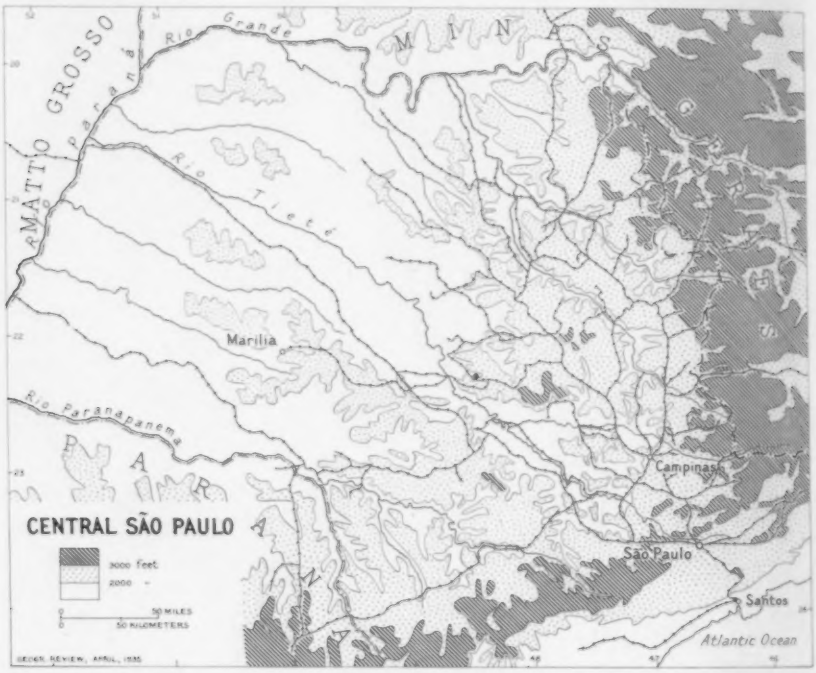


FIG. 1—Relief map of the plateau in São Paulo. The railway net is based on Mappa da Viaccão do Estado de São Paulo 1 : 1,000,000, Inspectoria Federal das Estradas, Rio de Janeiro, 1928.

managed—still well kept up and productive after more than eighty years of operation. A corner of the property overlooks the local market town of Campinas, nestling in its valley; motor road and railway connect it with the regional metropolis, São Paulo, 65 miles away, and with the port of Santos, 114 miles away.

The property has an area of about four thousand acres and occupies approximately the basin of a small stream. The ridge slopes are gentle, and the soils are moderately fertile, deep-brown silt residual on old crystalline rock. Coffee occupies 620 acres on the ridge tops and upper slopes around the headwaters of the stream. The rest of the land is relatively low and is considered unsuitable for this crop because of poor soil drainage and frost danger due to inadequate air drainage. Both reasons seem to be valid, though the practice of avoiding lower slopes tends to be followed simply as a matter of

custom. However this may be, the practice leaves space for supply crops apportioned to resident workers for family support, for pasture for the plantation livestock, for woodland, planted on slopes and growing wild on flood plain, to supply fuel and small timber, and for curing operations.

The small stream is dammed to form reservoirs providing water for cleaning the crop by the wet process. Beside it are the well equipped plant and paved drying floor. This installation indicates a degree of modernization, since the wet process requires more equipment and produces a better product than the older dry process still used for a large part of the Brazilian crop. Anomalous though it may seem, the wet process does not make coffee of as good aroma and yet is likely to produce a better average product than the dry process, because it separates the ripe berries from the unripe and the overripe —a mixture caused by the Brazilian custom of harvesting the whole crop at once by stripping the plants.

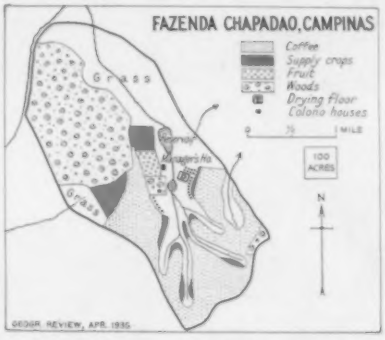


FIG. 2—Land occupance in the Fazenda Chapadão, Campinas District.

On the slope above the cleaning plant are rows of workers' houses. Work is done according to the *colono* system, in which the plantation is divided and allotted to workers, *colonos*, to be cared for. About a hundred *colono* families are required at Chapadão. Facing these houses, on the opposite side of the valley, are the owner's residence and offices. The owner is a wealthy Brazilian who lives in the city of São Paulo and leaves details of management to an administrator.

The coffee is of Arabian type, grown without shade in the customary Brazilian manner. Probably the reasons for this custom are less mandatory than are those for avoiding valley bottoms. The coffee plants are grown in clumps of three or four instead of singly as in other regions. Probably coffee growth is more vigorous and healthy without shade. Injurious insolation, excessive desiccation, and destructive winds are infrequent in this district, in contrast with some regions in lower latitudes, at lower altitudes, or in storm tracks. Here also gentle slopes and good soils have favored planting, without the need of supplementary vegetation to hold the soil or leguminous crops to enrich it. Furthermore, the Brazilian style of planting has prevailed under conditions of human settlement involving unrestricted expansion on virgin land, whereas the shade-tree method of the Caribbean region, for instance, has been used in some districts rather in response to conditions of restricted land area and depleted soils.

FIG. 3

FIG. 4

FIG. 5

FIG 3—Reservoir, coffee-cleaning plant, and drying floor of the Fazenda Chapadão; *colono* houses just beyond; coffee on upper slopes along the skyline.

FIG. 4—The owner's house, Fazenda Chapadão.

FIG. 5—Old coffee with tops dead except for a tuft of leaves, Fazenda Chapadão. Beans growing between rows at the right.

FIG. 6

FIG. 7

FIG. 8

FIG. 6—Main street in the frontier town of Marilia.

FIG. 7—Owner's house, Fazenda Miranda. Coffee three years and a half old at the left and fruit orchard at the right.

FIG. 8—*Colono* house in cutover land at the left, fazenda roadway in the center, coffee one year and a half old at the right, Fazenda Miranda.

Now that Chapadão is an old plantation, some shade might be beneficial. Many old coffee plants produce most of their leaves and all of their fruit close to the ground, as if the tops had been sacrificed in sheltering the lower branches. In competition with the new lands of the coffee frontier, Chapadão is handicapped not only by old plants and soil depletion but also by the coffee weevil, an insect pest that has invaded the Campinas district in recent years and is controlled only at considerable cost. Diversification or complete change of production is under consideration.

Many other products grow well on the plantation. The chief crops raised by the *colonos* on their allotted fields are corn, beans, and bananas. Bananas produce well for home supply but they cannot compete on a large scale with the product of the coastal lowlands. For commercial production of other fruits, however, the Campinas district has advantages. At Chapadão sixty acres of the lower slope near headquarters have been devoted in an experimental way to various fruits—pears, peaches, mangoes, pineapples, grapes, oranges, and grapefruit. Oranges have already proved successful as a product of the district and are marketed through city establishments. They are shipped to Argentina for an early-season market and to Europe for an off-season market from May to October, when northern-hemisphere oranges are not available.

So much for the old plantation—its present unsettled, its future uncertain. Now for the frontier.

Marilia District

Marilia is at the end of one of the railways advancing to the west, a railway of importance for coffee extension because it follows one of the projecting ridges of the plateau. The 350-mile journey from São Paulo requires sixteen hours. Marilia sprang into life a few months before the arrival of the line, as a trade center for the ridge district, a frontier boom town. Several roads reach out from Marilia into new land. A few miles northwest of the town, in the midst of virgin forest, is the Fazenda Miranda, occupying the basin of a small stream.

The original property had an area of 150,000 acres, but most of this was subdivided for sale, and only about a thousand acres were reserved for the owner's plantation. Although it is defined by the straight lines of a rectangular survey instead of by metes and bounds, the form of the plantation is much like that of Chapadão. The soil is much lighter than at Chapadão, distinctly sandy, overlying sandstone.

Coffee occupies 250 acres on the ridge tops and upper slopes, and more similar land is still available for coffee planting. There are

low fields of grass pasture as at Chapadão, but at present there are no separate fields of supply crops, the *colonos* growing their supplies between rows of coffee in the plantings. A field of sugar cane for livestock fodder and a small orchard of pears, oranges, and pineapples for home supply complete the crop list.

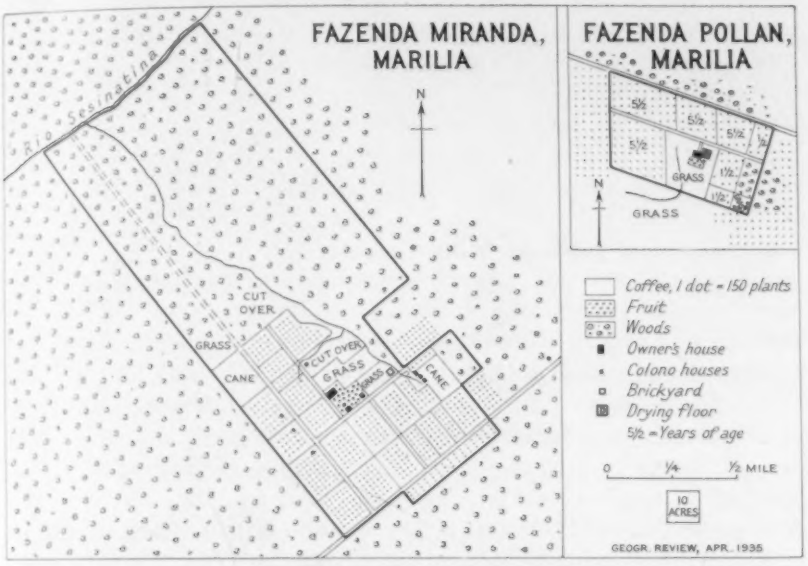


FIG. 9—Land occupance in fazendas Miranda and Pollan, Marilia District. The scale is about three times that of Figure 2.

Brick houses for the owner and the administrator have been built on a ridge overlooking the valley. The owner is a Brazilian physician who lives in the city of São Paulo. The resident administrator is of Spanish birth. Workers' huts are scattered near some of the plantings. Labor is scarce and hard to keep, so that there are only eight settled *colono* families, and additional transient labor has been required.

Each year a tract of forest gives way to coffee. The forest is of subtropical mixed hardwoods, mostly evergreens. Trees are felled at the beginning of the drier season. Toward the end of the season the area is burned over to dispose of brushwood, and when the summer rains begin coffee is planted, several seeds in each carefully prepared hole. Some of the fallen timber remains for several years, but by the time production begins it is not in the way. No cleaning equipment has been installed as yet, but before long it will be needed.

In the district there are some plantations of a different type. One of these is the Fazenda Pollan, which has an area of only 125 acres, but, like the others, occupies the head of a small drainage basin. The owner, an Italian immigrant, lives and works on the plantation. There are four *colonos*' houses. A patch of forest has been left to

FIG. 10—Coffee five years and a half old, Fazenda Pollan. Replacement planting with a shade cover of sticks in the middle foreground.

provide firewood and small timber. The proportion of land suitable for, and occupied by, coffee is greater than on the Fazenda Miranda—eighty acres, two-thirds of the property.

The most advanced coffee plants here are five and a half years old. No need of shade trees is indicated in these vigorously growing and producing clumps of the frontier. Wider spacing of plants has been adopted in the new plantations and has resulted in fewer plants to the acre but in fuller growth individually. At the Fazenda Pollan, as at the other plantations, there is interplanting of supply crops with coffee. Here there are also some temporary money crops, probably more characteristic of a small plantation started with small capital than of large, highly capitalized enterprises. One of these crops is tobacco, and another, of greater importance, is upland rice, so commonly planted on the young plantations that rice is temporarily the most conspicuous product of the district. In the town of Marilia the

FIG. 11—Coffee one year and a half old, upland rice between rows, and wood lot of the Fazenda Pollan.

several commercial cleaning and drying establishments, *beneficios*, are engaged mostly in handling rice rather than coffee, since volume production of the latter has hardly begun.

Not many of the forest trees are good for lumber, and much of the forest is cleared without any recovery; but there is enough incidental production to provide work for several sawmills in Marilia in making lumber for the new town and for older markets reached by the railway. The end of the railway is fairly buried under piles of fuel for the wood-burning engines.

These aspects of the frontier are temporary. Plans and expectations have assumed that the frontier itself is temporary; that the railway will soon proceed on its westward advance accompanied or preceded by establishment of new plantations and new towns. The present terminus is 140 miles from the Paraná Valley (Figs. 1 and 6). Much fertile ridge land lies beyond Marilia, land somewhat lower, but not too low for coffee.

The very structure of the coffee industry has been founded on advance into new land; the *colono* system of plantations, methods of planting and harvesting, objectives in marketing, public promotion—all have been shaped with reference to establishment of new plantations rather than maintenance of old ones.

So hasty has been the advance and so strong the spirit of bonanza production that only highly attractive areas have been occupied. Within the frontier of the coffee region less than twenty per cent of the land is devoted to coffee, and even in the districts of intensive coffee specialization less than forty per cent is so occupied. The present area of production, 5700 square miles, is only five per cent of the area of the state of São Paulo and less than half of the potential coffee land in the state. Thus, as far as land is concerned, the process of expansion may continue for many years.

Another factor has appeared. The present coffee-producing area is seemingly small for the premier source of a prominent world crop; but it is not small in fact for a crop of high yield per acre and low consumption per capita. In spite of the fact that coffee is a crop of narrowly specific requirements limiting it to fertile spots in low-latitude highlands, not many such spots are needed to satisfy the world market, and Brazil has no monopoly of them. Consumption, not capacity for production, appears to limit the industry.

Perhaps the era of expansion is at an end. In view of world-wide depression in general and the failure of Brazilian coffee policy in particular, the coffee region may retain its present form for many years to come, its gaps unfilled, its frontier unchanged. Marilia may grow old and still remain a frontier town.

THE NAIN–OKAK SECTION OF LABRADOR*

E. P. Wheeler, 2nd

[With separate map, Pl. IV, facing p. 254]

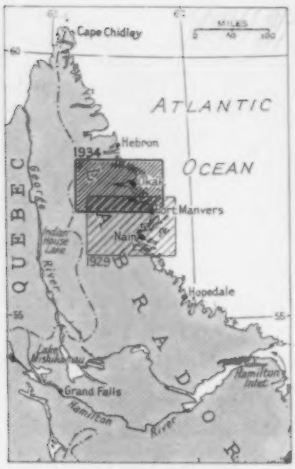


FIG. 1—Northern Labrador showing the areas mapped by the author.

The Labrador coast in the vicinity of Nain and Okak can best be described as a plateau some 2000 to 3000 feet in elevation, deeply dissected by glacial erosion and partially flooded by the sea. From a purely geographic point of view, this has resulted in two land zones and two water zones. In the outer water zone is a more or less wide belt of islands. Inside this is a zone of narrow bays that often reach a length of 30 miles. Inside the bay zone is a zone of nearly base-leveled, steep-walled valleys. Toward their heads these valleys tend to split into a network of smaller valleys with steep gradients that lead up to the final zone of the interior uplands.

ISLAND AND BAY ZONES

The islands are summits of hills more or less submerged, and their forms closely resemble the tops of the hills farther inland. The channels between them show great differences of depth with numerous reefs, corresponding to the irregular topography and minor summits of the mainland surface. The islands occur in great profusion and range in size from rocks awash at high water to land masses more than 20 miles long with peaks as high as 3000 feet. Locally, as in the Kiglapait Mountains, the eastern edge of the uplands has been better able to resist erosion, and great headlands project eastward, piercing the island zone.

In the bay zone the mainland is divided into strips by long, narrow bays, often fiord-like in their proportions. As a rule, from the Kiglapait Mountains to Tessiujaksoak they trend in an east-west direction; north of the Kiglapait they run southeast or northeast, and Okak Bay has an elbow where it changes from one of these directions to the other.

Their walls are often steep and high, with markedly glaciated forms. In places they are interrupted by more nearly north-south through valleys, often with the typical U-shaped cross section resulting

*The region is immediately north of the scene of the author's earlier travels described in "Journeys About Nain: Winter Hunting with the Labrador Eskimo," *Geogr. Rev.*, Vol. 20, 1930, pp. 454–468

from glaciation. Many of these cross valleys have been so deeply eroded that, before the recent emergence of the coast, they were sea channels, cutting off portions of the present mainland. One of the most striking of these former channels lay west of the Kiglapait Mountains, running from the head of Webb Bay to Tessiujak Bay. Some of the bigger islands of the present time are clearly formed from similar through valleys that have been cut so deep that their floors are still below sea level. The island on which Mt. Thoresby lies is an example.

The bay heads generally have broad tide flats—delta sands, where the entering brooks have no lakes near their mouths to act as catch basins, or boulder-dotted clay that would naturally be regarded as till. No good examples of glacial till were noted in the region, however. On the other hand, marine clays are not uncommon, and it seems probable that many of the bay-head deposits are of this class, the boulders perhaps having been added by deposition from floating ice.

The sides of the bays commonly have steep-to shores, but these are often modified by glacial deposits. Where the gradient is moderately steep to a little distance below low tide, boulder reefs are generally developed by the combined action of the tides and landfast ice. Such reefs are exposed at low tide, and either mud flats or tide pools lie between them and the shore. As a rule they are not well developed along shores where the water is shoal for some distance from shore at low tide. Such boulder reefs form along the shores of islands as well as of bays.

Valley Zone

The lower part of most of the main valleys entering the bays is disproportionately wide in comparison with the brooks that they contain, for they are the result of glacial erosion rather than of stream action. Over their broad flats—marine clays and delta sands laid down at the time of submergence—the brooks meander. Even in sections of valleys marked by these marine deposits the brooks may, however, show rapids, generally caused by accumulations of boulders from underlying glacial deposits. Lakes due to inequalities of glacial deposition or erosion are not uncommon. Some of the latter are very deep; for example, Tessisoak on the Fraser River.

As a rule there are only a few side valleys of importance entering the lower, nearly base-leveled parts of the main valleys. Many have the characteristics of hanging valleys, more or less well developed, and leave the main valleys on such a steep gradient that even dog-team travel is difficult along the lower part.

Perhaps a distance of 20 miles would be a fair average for the length of the broad, deeply glaciated parts of the main valleys, though

FIG. 2

FIG. 3

FIG. 4

FIG. 2—Broad sand-bar section of the Umiakovik River, just above the lower forks.
FIG. 3—Boulder rapid in lower Umiakovik River.
FIG. 4—View north across the Umiakovik Valley. Shows benches left by the river cutting marine deposits in the valley bottom.

FIG. 5

FIG. 6

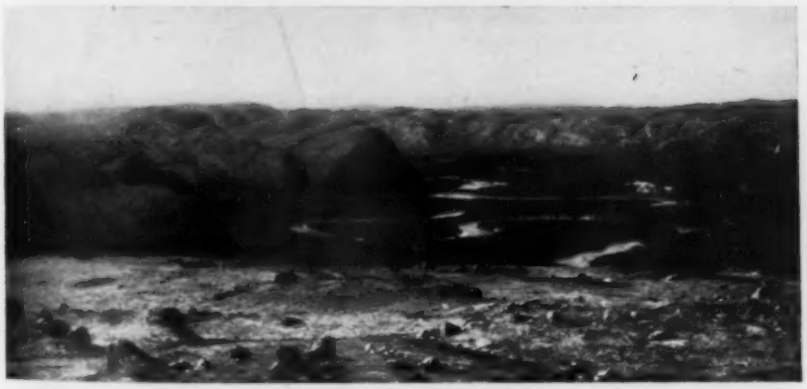


FIG. 7

FIG. 5—Lakes of the watershed region between the George River and the Atlantic drainage.

FIG. 6—Lateral moraine on the valley sides of the Umiakovik River. Looking east, just north of Umiakovik Lake outlet.

FIG. 7—Meanders in the flat-bottomed valley west from the head of Anaktalik Bay, south of Nain.

a few are much longer. Beyond this point the valleys break up into numerous branches which, except for local basins, rise rapidly to the level of the uplands of the interior. These branch valleys are comparatively narrow, with steep-cliffed walls. Bedrock outcrops in the stream bottoms are not uncommon, though much of the valley floors is covered with eroded remains of glacial deposits or talus from adjacent cliffs. Small ponds are not infrequent, either in the local basins or behind dams formed by talus or glacial deposits.

Interior Upland Zone

The highest summits of the upland zone average about 2500 feet in elevation above sea level in the region west of Okak, and perhaps nearer 1500 or 2000 feet west of Tessiujaksoak. In this zone the land surface is very irregular, but differences of elevation seldom reach 500 feet. The valleys are generally broad and flat-bottomed, and shallow basins some five miles across are not uncommon. The adjacent hills sometimes have quite steep slopes. Stream gradients are low, and lakes are numerous but mostly small and irregular in distribution. The drainage pattern is very erratic, so that the tributaries of different main streams overlap, and streams with westerly flow are not unusual in the upper part. Many minor divides may be encountered before the main divide between Atlantic drainage and George River drainage.

The main divide appears to lie farther to the east than would be expected from most existing maps. Both in the Okak section and west of Tessiujaksoak it was encountered at about longitude 63° 45′ W. As might be expected in view of the irregularity of the topography, the course of this divide is very complicated in detail.

Beyond the main divide the average elevation of the land does not appear to decrease greatly until the valley of the George River is reached; this is cut into the uplands to an elevation of perhaps 500 feet at Indian House Lake.

The writer has not seen enough of this country to generalize about it, but in the Indian House Lake section the valleys of the George and its tributaries from the east do not appear to be so straight or so steep-walled as the main valleys draining into the Atlantic. Certainly nothing was seen to compare with the valley of the Fraser River in these respects.

Phenomena of Glaciation

The results of glaciation are to be seen on all hands in this, as in every other, section of the Labrador peninsula. Glacial striae and grooves are best preserved on rock surfaces that have been recently exposed by the lowering sea level. Their directions at the lower levels are somewhat variable, tending to follow the axes of the chief bays

and radiating slightly from their mouths. Thus they give information on the local, rather than the regional, direction of ice movement. Although weathering has destroyed much of the striation at higher levels, glaciated rock surfaces have been preserved in many places where conditions were favorable. Granite and pure anorthosite hills often have the glacial polish so well preserved that bare slopes of rock glisten in the sun after rain. Mt. Kauraraluk, in 57° 21′ N. and 62° 53′ W., west of Umiakovik Lake, has striations on its summit. As it is the highest summit in the region, these striations should give a fairly accurate idea of the regional direction of ice movement and point the line toward the center of accumulation of the Labrador ice sheet. They run between N 75° E and due east, true readings. These values taken in conjunction with those given by Odell for the period of maximum glaciation near the northern tip of Labrador[1] give a center of accumulation in about 57° N. and 70° W.

Small but interesting features are the potholes (see Fig. 9) on the sharp summit of one of the highest peaks at the western end of the Kiglapait Mountains and on the top of an isolated 1400-foot summit south of the lower part of the brook entering the head of Anaktalik Bay, just south of Nain. In both cases they seldom exceed 6 inches in depth or 18 inches in diameter and occur in clusters. They may well have been made by moulins in a crevasse localized by the underlying peak. Even if they are only the result of simple stream action, the glacial ice must have covered the land to a sufficient depth to allow these summits to outcrop in the bed of a stream on the surface of the glacier.

More or less well developed amphitheaters are not uncommon on the flanks of the higher hills. They are probably cirques produced by local glaciers during the retreat of the continental ice sheet.

Clastic deposits of glacial origin are abundant throughout the area. In many places they are so well preserved that the coarser morainic material has not settled into positions of stable equilibrium, and it might almost be believed that they were deposited by modern glaciers, except for the disintegrated character of the more readily weathered boulders. The scantiness of vegetation, especially at higher levels, adds to this effect.

Terminal moraines are not developed on a large scale, but perhaps they are the cause of the series of lakes in the Fraser Valley below Tessisoak. Small lateral moraines are occasionally met with high on valley walls. One of the most striking examples occurs in Umiakovik Valley, west of Okak, between Umiakovik Lake and the upper west fork of the river. Deposits of tillite do not appear in the upland zone. If they occur in the valley zone, they have been buried by

[1] N. E. Odell: The Mountains of Northern Labrador, *Geogr. Journ.*, Vol. 82, 1933, pp. 193–210 and 315–325; reference on p. 316.

FIG. 8—Boulder reef formed by action of land-fast ice and tide. Shore of Satorsuak Island, south of Nain.

marine deposits during the postglacial submergence of the land, so that they are not well exposed. Esker ridges are well developed in many parts of the upland zone. They were noted taking their serpentine course over hillsides and across valleys in the main divide region. They were also seen following the bottoms of several valleys leading westward into the George River and Indian House Lake.

Where all other detrital deposits fail there still remain erratic boulders of glacial origin dotting the nearly bare bedrock. They form perhaps the most characteristic feature of the landscape where vegetation has not buried them. Even the winter snows do not hide them on the wind-swept ridges.

OTHER DETRITAL DEPOSITS

Beaches and deltas formed when the sea level was higher than it is at the present time have been described so often in discussions of the Labrador coast that they do not need further mention. None were found by the writer at a greater elevation than 325 feet above sea level.

At a number of points in the upland zone stratified sand and gravel deposits were met with far above the highest level to which the sea attained. They form benches on hillsides and plains in valley bottoms and are undoubtedly abandoned lake deposits. The outline of one of the smaller lakes of this character was traced, and it was found to be the result of the blockage of a valley by glacial deposits that were subsequently cut through by stream erosion. Many others no doubt have a similar origin. In the vicinity of the stream flowing from Mistinibi Lake the benches were formed in basins far too large to be outlined in a hasty journey through the country. Judging from their wide distribution, it seems probable that they were laid down in large lakes formed at the margins of the retreating glacier. At several places in the upland zone the land surface was found to be paved with angular blocks of rock. These deposits are of uncertain origin. They have been discussed in some detail by Coleman.[2]

[2] A. P. Coleman: Northeastern Part of Labrador, and New Quebec, *Canada Geol. Survey Memoir 124*, 1921, p. 29.

Relation Between Geology and Topography

Fig. 9—Pot holes on the 1400-foot summit in the valley west from the head of Anaktalik Bay, south of Nain.

Although glaciation has been the agent that has produced most of the existing topography, the nature of the underlying rocks has been the chief factor in determining the resulting forms. Areas of anorthosite and granite tend to be higher than adjacent areas of gneiss, probably because the foliated nature of the latter has facilitated plucking action by the glacial ice. This would explain the marked eastward extension of the mainland at the Kiglapait Mountains, where the eastern and northern shores follow the contact between gneiss and the anorthosite complex fairly closely. Similarly, the belt of low country running south from Tessiujak Bay, northwest of the Kiglapait, is defined, at least throughout its northern half, by gneiss. The isolated peak north of Iglosoataliksoak Lake and the mountains west of the Angutausugevik drainage basin coincide with the reappearance of plutonic rocks that are probably also a part of the anorthosite complex, though they are, at least in part, acid in character. The northern margin of this complex is indicated by the pronounced scarp south of Serkoujavik Brook in the Okak Bay country and the isolated summit east of Ikinet Brook, while the lower hills around Saputit Lake to the north are gneiss, except in the section south of the outlet.

The tendency toward greater elevation of large bodies of igneous rock becomes so pronounced in places that summits in such areas on the coast, and even on islands, may be higher than summits in the divide region, which is largely composed of gneiss. Thus the Kiglapait Mountains, Mt. Thoresby, and Mt. Lister are all about 3000 feet high, and the Kaumajet Mountains are even higher, whereas summits in the divide region seldom exceed 2500 feet. The Kaumajet, though chiefly volcanic rather than plutonic, were probably able to resist the plucking action of the ice better than the gneisses because their planes of foliation approach horizontal, whereas those in the gneiss practically always have steep dips.

Throughout much of the more basic phases of the anorthosite complex regional jointing occurs, running very nearly east-west. Zones of such joints appear to be the cause of the long, straight east-

FIG. 10—Caribou trail through open white-spruce woods in the Okak region.

west valleys and bays characteristic of the region between Tessiujaksoak and Webb Bay. Such a joint system is strikingly developed in the south wall of the valley entering the head of Anaktalik Bay about 14 miles west of the bay head (Fig. 11). No evidence was found to indicate that any of these main features were the result of erosion along fault planes, though several relatively small north-south valleys were found to lie along zones of brecciation, probably produced by faulting.

In the Kiglapait region jointing tends to parallel the arc of the northern contact of the anorthosite complex. This has resulted in the formation of a series of concentric ridges and depressions of varying magnitude convex to the northward. They control the orientation of the major features of the region and are very striking when seen from an airplane in the early summer while the snow still remains in the depressions but has melted from the ridges. Topographic expression of diabase dikes in the region has already been briefly described by the writer.[3]

In the gneiss areas the foliation as a rule trends west of north, and ridges and ponds tend to be elongated in this direction also. This is very noticeable west of the area of intrusive rocks around Umiakovik

[3] A Study of Some Diabase Dikes on the Labrador Coast, *Journ. of Geol.*, Vol. 41, 1933, pp. 418-431: reference on pp. 419-420.

Lake in the Okak section and also around the head of Tikkoatokak Bay. Certain types of gneiss, such as hornblende gneiss and acid garnet gneiss, are often the ridge-forming elements. Perhaps there is also a tendency for hills to develop in the rare cases where the dip of the foliation is low. Relief in the gneiss areas tends to be less than in the areas of intrusive rocks, perhaps because of a lesser development of joint systems in the gneiss.

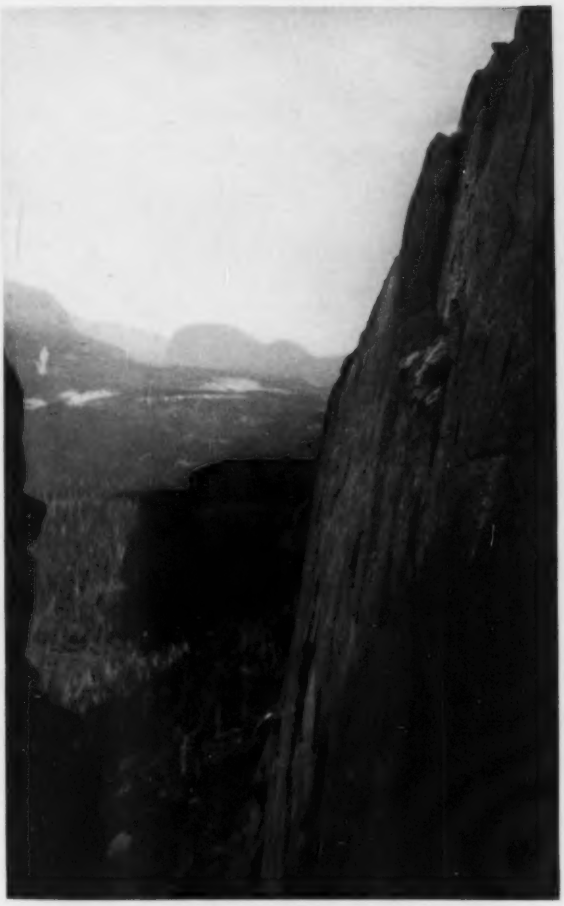


FIG. 11—South wall of valley west from Anaktalik Bay, south of Nain, due to jointing. Shadow of valley wall visible on spruce.

VEGETATION

From a biological point of view it would probably be best to divide Labrador into five, instead of four, zones by splitting the island zone into outer and inner sections. This is perhaps most noticeable from an ornithological viewpoint, but it is recognizable to a lesser extent from the viewpoint of vegetation.

On the more exposed parts of the islands vegetation is confined to lichens, mosses, grasses, and flowering plants, as in the upland zone. Trees appear only in sheltered places. They are seldom found on the outer islands, where they are badly stunted and contorted. They are generally spruce, though tamaracks occur under favorable conditions.

Timber line is about 1000 feet above sea level. Thus the deeper valleys of the mainland are wooded, while the adjacent uplands are barren. Trees seldom reach a diameter of three feet, even in the most sheltered valleys, and these larger specimens taper more rapidly than

the smaller ones, so that 50 feet would probably be a generous estimate of their height.

By far the greater number of the trees are conifers—black spruce and tamarack on poor or moist ground, white spruce on dry sandy ground in sheltered parts of valleys, and a little balsam fir in the deeper mainland valleys. Deciduous trees are relatively rare, being chiefly confined to a small birch that may become good-sized on steep valley sides. A single hairy-petioled balsam poplar (*Populus balsamifera michauxii*[4]) was found growing on low clayey ground in the valley west of Anaktalik Bay (56° 30′ N.).

For several hundred feet above timber line the hillsides are often carpeted with a thick growth of dwarf birch. Willow and alder are common, of course, even some distance above timber line. Above this level through all the interior upland zone there is practically nothing but a thin covering of grasses, etc., which only partially conceals the myriad glacial erratics. In addition, a few dwarf willows and alders occur in the more sheltered spots.

South of Nain, whether because of slightly milder weather conditions or because of somewhat lower elevation, small patches of trees can be found under the shelter of hills, even in the upland zone, and travelers by dog team who are acquainted with this territory can nearly always camp where firewood and tent poles are procurable.

As the valleys draining into Indian House Lake in the vicinity of Mistinibi Lake are descended, spruce becomes more abundant, until the valley sides near the former are entirely wooded. Near the mouth of the brook draining Mistinibi Lake there is a marked contrast between the heavy woods east of Indian House Lake and the sparse growth west of it.

Farther south on the Labrador coast, in the Hopedale section, judging by what was seen on a short trip inland, the land is lower and only the hilltops are barren. To the north of Okak the Mugfords appear to be entirely without trees, even in the lower valleys. Napartok Bay, north of them, is reported to have a good stand of spruce in the valley at its head. This is said to be the limit of trees on the Labrador coast. Hebron Bay, only a few miles farther north, running equally far inland, and with deep valleys entering its head, should be an equally favorable locality. This sharp transition suggests the possibility that the limit of trees on the Labrador coast is not due so much to climatic conditions as to absence of migration routes for the trees between the wooded valley of the George River and the valleys draining into the Atlantic on the northern section of the coast.

Some climatic observations are now in order, though the writer's meteorological notes do not extend over a long enough period of years for safe generalization.

[4] Identification by Dr. K. M. Wiegand of Cornell University.

Climatic Conditions

It appears that the Kiglapait Mountains may be the locus of a change in weather conditions. This is especially noticeable in winter, since a traveler occasionally finds marked differences in the character of the snow in passing from one side of this range to the other. A point of interest is that, although thunderstorms are infrequent throughout the entire area, they seem to be far fewer in the Okak region than they are in the Kiglapait and to the south of them.

Data on temperatures are based on observations taken at 8 a. m., 2 p. m., and 9 p. m. July was the only month in which frosts were not recorded at least during the night. In this month the thermometer reached 85° F. only rarely. In winter occasional temperatures as low as −25° F. have been noted, but, on the other hand, one or two short thaws may be expected. Probably the average temperature is slightly below 0° F. in winter and around 50° F. in summer; in April and May it is around the freezing point. Temperatures are notably uniform in May, at least on the outer islands. These temperatures apply to the coast around Nain; as a rule those in the interior seem to run about 10° lower. During the winter months diurnal variations in temperature are relatively insignificant; but there is a very marked inverse ratio between barometer and temperature readings, which begins to be noticeable in September and disappears in May.

Bodies of fresh water begin to freeze up in the latter part of October. After the middle of November the salt water starts to freeze in sheltered coves, and slob ice begins to develop. With the exception of places where heavy tidal currents occur, the channels between the islands are practically always frozen over by Christmas. Late in April or early in May ice on the rivers begins to be bad in spots, and the ridges of the uplands begin to be bare enough of snow to cause difficulty in dog-team travel. Landfast sea ice generally breaks up sometime in the latter part of June. Perhaps the average climate in the Okak region is slightly colder than that south of the Kiglapait, since the autumn freeze-up seems to be a little earlier there and the spring thaw later.

Throughout the year easterly winds are generally accompanied by thick weather—fog and rain with temperatures dropping to the low 40's in summer, and snow with temperatures rising toward the freezing point in winter. Southwesterly winds in summer often bring hot, hazy weather, with high humidity. Westerly gales increase in frequency and violence from the latter part of September, reach a maximum during January and February, and drop off markedly in March, though often an unusually heavy gale occurs early in July.

There is generally not a great deal of snow in January and February, but there may be numerous heavy falls in March. Occasional

rains occur, beginning in April, but precipitation is light in April and May. There is usually a good deal of thick weather with numerous light rains in June. This condition may last through July, with occasional heavy rains in addition. Clear weather often prevails in August. September may be very disagreeable, with wet snow falling in the interior. Snow begins to appear at sea level in October, but precipitation is seldom heavy after September.

Traveling Conditions

Travel by canoe is feasible in the bays and among the islands along most of the coast from Okak south. The only obstacles are a few long crossings with no sheltering islands, such as the mouth of Jack Lane Bay south of Davis Inlet, and several exposed capes, such as Cape Kiglapait. The long crossings and the surf on the outer islands make it desirable to avoid this zone unless one is willing to risk being caught in the pack ice when it is close to the coast and has reduced the ground swell. The canoeing season on salt water begins with the breaking up of the landfast ice about the end of June and ends as cold weather and autumn gales make conditions increasingly unpleasant in October or November.

Most of the main brooks entering the bays are navigable by canoe to the end of the base-leveled part of their valleys. Portages are more or less numerous on account of the accumulations of boulders that choke the brooks in places. In a few brooks, such as Kingurutik, northwest of Nain, these accumulations are so numerous that the brook becomes useless for canoeing. According to local report, many of the brooks south of Tessiujaksoak are much bigger than those in the Nain-Okak region and are very good for canoeing, leading far into the interior. They are said to be often interrupted by one or two big falls or rapids.

In the upland zone the lakes, though very numerous, seem to be too small and irregularly distributed to make good portage routes to the George River, though the Indians know several between Indian House Lake and the Davis Inlet section. Any attempt to get a canoe to the upland zone from Tessiujaksoak north will probably involve one long portage with a climb of 1000 feet or more out of the valley zone. The brooks entering the George River from the east have steep gradients and are full of rapids if the upper part of the one west of Umiakovik Lake in the Okak region is a typical example. They may be navigable for expert rivermen, but the writer has not had enough experience to be able to judge. The Indians apparently use much of the Mistinibi drainage system for canoeing, but that seems to contain an unusually large number of lakes.

Travel on foot with a pack is badly hampered in the bay and valley

zones by the vegetation at lower levels and the ruggedness of the hills. Practically no trails exist except those of caribou and bears, and these are rarest in woods where they are most needed. In the upland zone, though vegetation is no longer an obstacle, it is impossible to proceed in a straight line because of the endless series of ponds. Neither the boulder-strewn slopes nor the boggy stream bottoms afford particularly good footing, but where esker ridges can be used they aid the traveler a good deal. As he approaches the George River he is likely to be turned back or have to make long detours because of brooks too deep and swift to ford.

Probably the dog team is the best means of travel. Through much of the winter, gales keep the snow in such good condition that snowshoes are rarely needed, except in heavy woods, and these can nearly always be avoided by following waterways. One of the greatest advantages of dog-team travel is speed, five miles an hour being not unusual in good going. However, even this method has its handicaps. There is seldom enough snow to make a dog team practicable before December, and from then until March gales may make it difficult or impossible to travel. In March deep, soft snow may interfere, and by the end of April snowless ridges may cause a good deal of trouble. Also, for long, unsupported journeys the amount of dog feed that must be carried is very great.

Possibly where time is no object a hand sledge or a toboggan would be even better than a dog team on such journeys in the interior. The problem to be solved in making this choice is whether the comparatively short time that a dog team can travel without a renewal of feed outweighs the slow rate of travel by hand sledge. The dogs in Labrador are accustomed to a diet of seal meat and do not keep in good condition when fed on caribou meat without seal fat. The distribution of caribou in the interior is far from uniform, and their location is uncertain. Thus a driver who starts with little besides fat is very likely to have his journey come to an untimely end through shortage of dog feed. If the traveler starts with a hand sledge, he may be able to carry provisions enough to last for a longer time than he could with a dog team, and one caribou killed will replenish his supplies for many days, whereas it would supply dog feed for only a few days at most. On the other hand, the short distance he can cover in a day reduces his chances of encountering caribou.

APPENDIX: NOTES ON MAP OF OKAK BAY REGION

The methods employed in the field work connected with the map of the Okak Bay region of Labrador were very similar to those employed in connection with the writer's map of the Nain region.[5]

However, certain refinements were introduced that have materially increased

[5] Journeys About Nain, pp. 467–468.

the accuracy of this map. Observations for latitude and longitude at Nutak and the head of Okak Bay were taken on the sun with a seven-inch sextant and a mercury artificial horizon, correct time being obtained by radio on the day of the observation. They should be correct within one minute.

Other observations for latitude and longitude were made with a box sextant reading to minutes and a black glass artificial horizon. The sextant was faulty, and it was not until it had been in use for a long time that differences between observations at a given station were reduced to one or two minutes. Time was obtained from three watches that were checked by radio as often as possible. They were not remarkable for uniformity of rate, but errors introduced by them were probably not much greater than those due to the sextant.

South of the area mapped the accurate location of a number of points was kindly given to the writer by Commander Wyatt, R.N.[6] Some of these points were tied in with the triangulation net of the map and increased its accuracy considerably.

The accuracy of compass bearings was materially increased by the use of a tripod for the Brunton compass and determination of compass error by sun bearings at practically all triangulation stations. Contrary to the statement made in the notes on the map of the Nain region, nothing systematic could be found in the compass errors at different points that would make it possible to predict the character of the error at a given station. The local deviations nearly always amounted to several degrees and on one hill in the Nain region rose to 60°.

Beyond the last triangulation stations west of Umiakovik Lake in the Okak Bay section the mapping depends on a time-rate traverse on foot, tied in to latitude and longitude determinations at the westernmost point reached. The observations were made before the peculiarities of the sextant were thoroughly understood, and under unfavorable conditions, so that the error in the results may be exceptionally high. The difference between the location of the point by dead reckoning and by astronomical observations was 2.5 miles. Half this difference was absorbed by a slight increase of the assumed rate of walking, justified by the results of plotting the portion of the foot traverse that fell within the triangulated area. Thus the probable error of the location of points on this traverse may well be about a mile.

On this traverse elevations depend on simultaneous readings of an aneroid barometer in camps and a mercurial barometer at Nain, the adjusting screw of whose mercury reservoir was out of order. Scale error of the aneroid on the mercurial barometer was determined before and after the journey. At camps occupied on more than one night differences of elevations computed were as great as 200 feet. However, many of the camps were occupied on both the outgoing and the return journeys, some of them for several days. Thus the resulting averages may be accurate to 100 feet.

Several points located by the old methods, and also by the more refined methods here described, were accurately located by the British Admiralty, and it is of interest to note the size of errors revealed by comparing these results, as some indication of the accuracy of the maps. The Nose, which was the origin for mapping in the Nain section by both methods, was erroneously located by 0.6 miles on the old map and 0.5 miles on the new; Mt. Thoresby, the farthest point from the origin for which data were obtainable, 3.0 miles on the old map and 1.15 miles on the new. This was the maximum error detected. However, points farther from the origin and those outside the triangulation net would probably show greater errors.

The projection used in this map was conic projection with rectified meridians and two standard parallels, as described by E. A. Reeves.[7] The standard parallels selected were latitude 61° N. and latitude 52° N.

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[6] Compare A. G. N. Wyatt: Surveying Cruises of H.M.S. *Challenger* off the Coast of Labrador in 1932 and 1933, *Geogr. Journ.*, Vol. 84, 1934, pp. 33–53.

[7] E. A. Reeves, edit.: Hints to Travellers, 10th edit., London, 1921, Vol. I, pp. 91–93.

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RECONNAISSANCE MAP OF LABRADOR IN THE VICINITY OF OKAK BAY

BY E. P. WHEELER, 2ND 1934

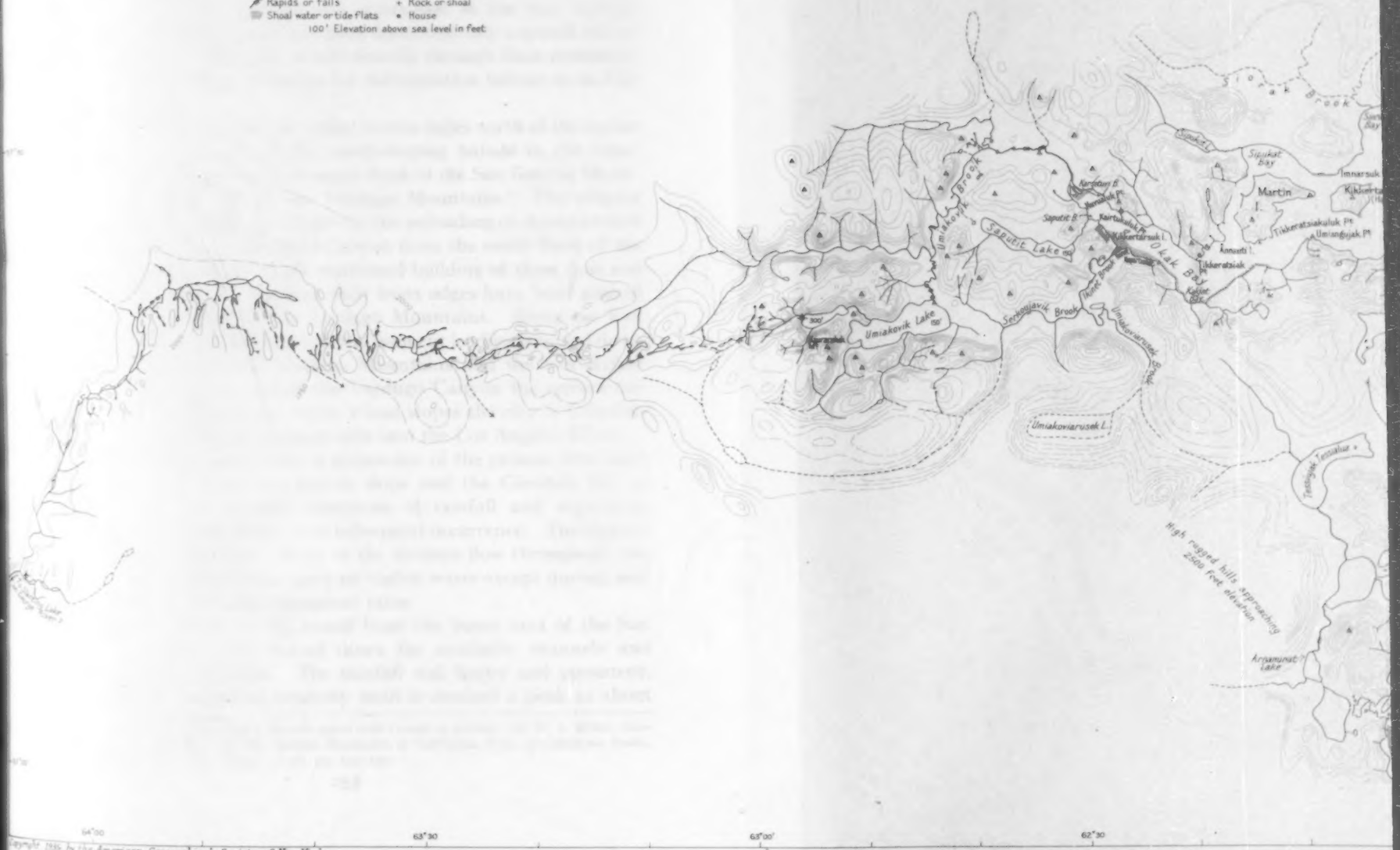
SCALE 1:500000

0 5 10 20 MILES
0 5 10 20 KILOMETERS

Contour interval = 250 feet

- Latitude observation
- Longitude observation
- Triangulation station
- Prominent summit
- Rapids or falls
- Rock or shoal
- Shoal water or tide flats
- House

100' Elevation above sea level in feet



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62°30'
62°00'
Napartok Bay
Kaumajet Mts.
(Mugford Mts.)
Real Island of Kamajet
Ujuaksujulik Bay
Parkavik
Slonak Brook
Sipukat I.
Sipukat Bay
Martin I.
Imnarsuk Pt.
Kikkertak I. (Hans I.)
Tikkeraksiakuluk Pt.
Umiangajak Pt.
Annauti I.
Tikkeraksiak
Okak Bay
Umiakovik Brook
Saputit Lake
Umiakovik Lake
Serkosiavik Brook
Umiakoviarusek Brook
Umiakoviarusek L.
Kaipokok Bay
Nuasornit
Kedlavik Brook
Tessiujak Tessuluk
Tessiujak Bay
High rugged hills approaching 2500 feet elevation
Arnanunat Lake
62°30
62°00

61°30'
61°00'
Nanuktut
ATLANTIC OCEAN
Uganek
(Cape Mugford)
Kairtuinak I.
Uvingajok
(Saddle I.)
Ukusiksalik I.
Stirrups
Semokutak I.
Kikkertarjote
(Lundberg I.)
Silutalik
Ametok
Operngeviksoak
Njakuk
Iglosoatlialuk
Nuasornak
Ametok
Iluvertalik
Kikkertasoak
(Dawes I.)
Killitakuluk
Allavik
(Graveyard I.)
Naujatset
Kiglapait Mts
Cape Kiglapait
Okkitik
(Orphan I.)
Nuasornatannak
(Loaf Head I.)
57°30'
57°00'
Man-o-War
Port Manvers

UNIV. OF MICH.

ALLUVIAL FAN FLOODING

THE MONTROSE, CALIFORNIA, FLOOD OF 1934

W. D. Chawner

DURING the last day of 1933 and the first day of 1934 Los Angeles County was struck by the greatest rainstorm of any 24-hour period in its history. The greater part of the damage done by the storm was concentrated in the communities of Montrose, La Crescenta, and Glendale, where a number of people lost their lives and several hundred houses and other property were partially or completely destroyed. The chief cause of this localization of the principal damage was a burnt-over watershed in the San Gabriel Mountains whose forest cover had been destroyed only a month before the storm and whose drainage passed directly through these communities. It is seldom that retribution for deforestation follows so swiftly and unmistakably.

Montrose and La Crescenta, about twelve miles north of the center of Los Angeles, are built on the south-sloping bajada in the intermontane depression between the south flank of the San Gabriel Mountains and the north flank of the Verdugo Mountains.[1] The alluvial fans on which they stand were built by the unloading of debris carried down Halls Canyon and Pickens Canyon from the south flank of the San Gabriel Mountains. In the continued building of these fans and their contemporaries on the west their front edges have been pushed against the north slope of the Verdugo Mountains. Along the foot of this slope a broad and deep wash has been cut leading into and down Verdugo Canyon between Verdugo Mountains and the San Rafael Hills. At the southern end of the Verdugo Canyon the stream has built up another alluvial fan, upon whose slopes the city of Glendale stands. At its outskirts drainage falls into the Los Angeles River.

The flood of January 1 was a recurrence of the process that built the Montrose–La Crescenta bajada slope and the Glendale fan—a process that, under normal conditions of rainfall and vegetation cover on the mountain slopes, is of infrequent occurrence. The climate of this region is semiarid. None of the streams flow throughout the year. In fact, most of them carry no visible water except during, and for a short time after, the infrequent rains.

All day December 31 the runoff from the burnt area of the San Gabriel Mountain front roared down the available channels and overflowed many of them. The rainfall was heavy and persistent, with gradually increasing intensity until it reached a peak at about

[1] This depression is essentially a downdropped fault trough or graben. See W. J. Miller: Geomorphology of the Southwestern San Gabriel Mountains of California, *Univ. of California Publs., Bull. Dept. of Geol. Sci.*, Vol. 17, No. 6, 1928, pp. 193–240.

11.45 p. m. According to the accounts of eyewitnesses, between 11.40 and 12.00 p. m. the streams in Halls and Pickens washes split at several different places in their courses through Montrose and La Crescenta, taking the shortest radial paths to the bases of their fans. It was this sudden and final spurt of the flood that caused the chief destruction of property and lives. One report from Pickens Canyon runs:

> About 11.40 we heard a dull roar reverberate through the canyon. Before we could get to the porch a flood of water swept through the house: all of us were carried far down the canyon. Then from the higher ground we watched: a wall of water nearly fifteen feet high roared through the canyon, carrying with it houses, trees, boulders, and people.

The sudden and simultaneous burst of the two streams into new channels was apparently caused by a rather sudden increase in the amount of flow from the mountain canyons at the time when precipitation was heaviest. What exactly was the nature of this occurrence: was it a mudflow or a violent stream flood?

Mudflow or Stream Flood?

Mudflows and stream floods are common on bajada slopes in mountainous, semiarid regions. Pack has described a flood along the west front of the Wasatch Mountains, Utah, in which he recognized three periods of flooding, the first a torrential stream flood, the second a mudflow caused by the breaking of debris dams in the mountain canyons, and the third a period of dwindling stream flooding.[2] Blackwelder in his excellent article on mudflows[3] says:

> The descriptions . . . indicate that the mudflow of the semiarid mountain canyon is intermediate between the better known landslide and the ordinary stream-flood. There are, in fact, all gradations between them . . . The mudflow contains just enough water to swell the clay colloids, reduce internal cohesion, and make the mass slippery. . . . In most respects the mass behaves much like a lava flow. . . . the various phenomena indicate that it slides or glides over the surface without that internal churning that characterizes a rapid stream of water. Irregularities in the base doubtless cause some commotion, but many of them, such as trees, are sheared off and carried forward.

Mudflows characteristically terminate with sharp, abrupt edges and are deposited in definite sheets, which in some localities, notably along the eastern margin of the Sierra Nevada Mountains, have recurred with some regularity and are superimposed one upon another in such a manner as to form distinct terraces.

It is evident from the observations made by the writer that the Montrose–La Crescenta flood was largely a violent, torrential, moun-

[2] F. J. Pack: Torrential Potential of Desert Waters, *Pan-American Geologist*, Vol. 40, 1923, pp. 349–356.

[3] Eliot Blackwelder: Mudflow as a Geologic Agent in Semiarid Mountains, *Bull. Geol. Soc. of America*, Vol. 39, 1928, pp. 465–483; reference on pp. 472–473.

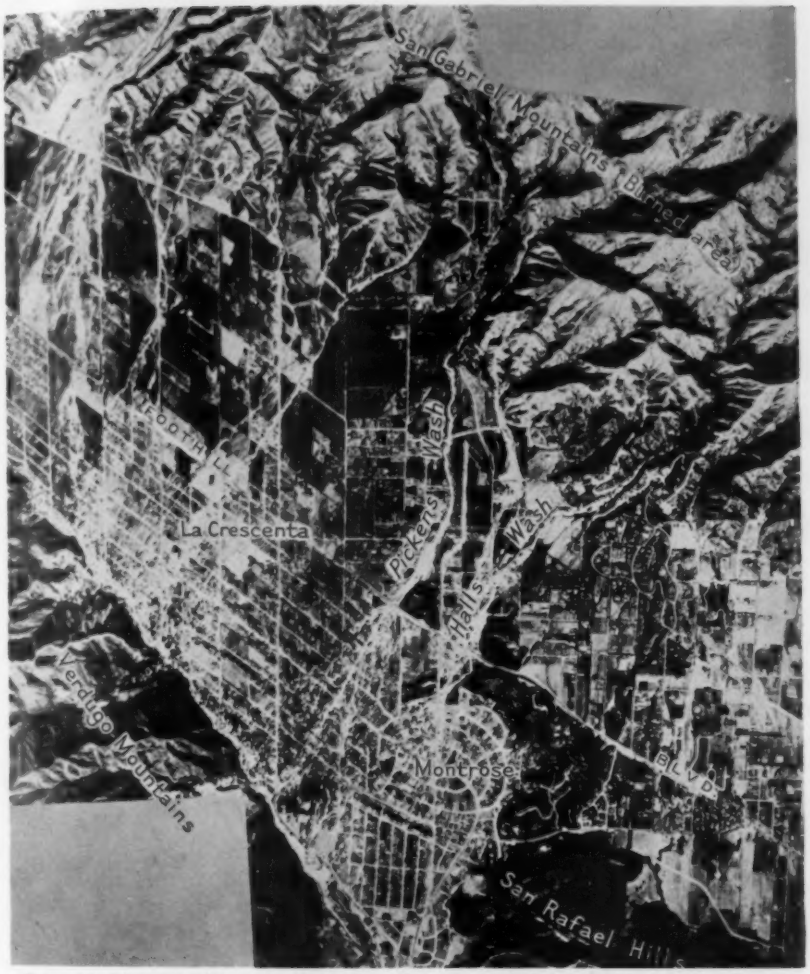


FIG. 1—Aerial mosaic of a portion of the burned-over watershed and the Montrose-La Crescenta flooded bajada slope. (Courtesy of Fairchild Aerial Surveys Inc.)

tain stream flood whose waters were overcharged with rubble. Its course was split into definite, radial stream channels. Its movement was swift. Trees and houses were beaten down by a bombardment of water and boulders and not "sheared off" as would be expected in a mudflow. Insecurely placed houses and sheds were floated away on the surface of the current. Locally, and perhaps intermittently, mudflows occurred consisting of the thickened debris collected back of partial dams such as bridges, culverts, houses, etc., or of the settling sand and rock collecting along the bottoms of the stream currents. Nevertheless, sedimentation from mudflow is apparent in many of the culverts in Pickens and Halls washes. In these places an inadequate channel, perhaps partly choked by vegetal debris, formed a temporary

FIG. 2

FIG. 3

FIG. 4

FIG. 2—Deposit in Pickens Wash, twelve feet deep at its thickest point.

FIG. 3—Rudely stratified deposits of sand and gravel in an east-west street, four feet at thickest.

FIG. 4—Pickens Wash looking downstream. The hummocky surface on the left suggests a mudflow. The large boulder weighs about ten tons.

and partial dam behind which sand and rock settled and later pushed on into the culvert. Even though the accumulated material was coarse-grained (see Fig. 8a), it was lubricated enough by silt and water to flow a short distance.

In some houses rock debris entered in part at least as mudflow material. The outside north walls, facing the onrush of the flood waters, themselves formed the temporary dams back of which sediment collected until such time as the pressure overcame the resistance of the walls and the collected rock and sand flowed into the houses (see Figs. 5 and 6). Even where mudflows were forming there was a large excess of water in the upper part of the flow, which rushed onward as a stream torrent. Because of the superabundance of water the finest materials were carried on into the Los Angeles River, to be deposited later in the mud flats along the coast or in the Pacific Ocean. The ocean was brown with silt for a reported dis-

tance of twelve miles beyond the mouth of the river.

Character of the Flood Sediments

The deposits of an alluvial fan are characterized chiefly by their coarseness, the angularity and slight decomposition of their fragments, and their low degree of sorting. A. C. Lawson[4] proposed the name "fanglomerate" for the coarser deposits of an alluvial fan, and its use has been accepted by most geologists. The Montrose deposits were fanglomerates, or rather "fangravels" (by virtue of their being new, unconsolidated sediments). Stratification in them was irregular at its best and in many places was entirely lacking. Even where the sediments were obviously stream deposited (not mudflow) stratification might not be at all dis-

[4]The Petrographic Designation of Alluvial Fan Formations, *Univ. of California Publs., Bull. Dept. of Geol. Sci.*, Vol. 7, No. 15, 1913, pp. 325–334. The term "bajada breccia" is synonymous with "fanglomerate" (W. H. Norton: Studies for Students: A Classification of Breccias, *Journ. of Geol.*, Vol. 25, 1917, pp. 160–194).

FIG. 5

FIG. 6

FIG. 7

FIG. 5—The north wall of a house on Pickens Wash. Note coarse gravel from splashings on roof.

FIG. 6—Inside of the house shown in Figure 5. Unstratified, unsorted material, three feet thick, probably from a mudflow (see Fig. 8a).

FIG. 7—A characteristic nonstratified deposit, three feet thick with boulders up to 40 inches scattered through it.

cernible, but in such cases a rude lenticularity was apparent. In the coarser fangravels boulders of tremendous size (Figs. 2, 4, 7) were found associated with a mixture of material ranging down to fine sand in size. In general, coarseness decreases from the apex of the fan downslope, and the finest material will be found in greatest abundance at the outer part of the fan.[5] The weights and distances from the canyon mouth of the greatest boulders were: 32 tons at 7000 feet; 23 tons at 7900 feet; 11 tons at 8400 feet; 5.5 tons at 9400 feet; 5 tons at 9800 feet; 1.6 tons at 9600 feet; and 1.2 tons at 11,800 feet.

Boulders of much greater size—one estimated to weigh 50 tons—were found, partially buried in fangravel but unmoved by the January flood. They were undoubtedly left by some former period of still greater flooding.

It was impracticable to include the boulder of one to three feet in diameter in making a complete mechanical analysis of the sediments, but a number of samples of finer gravel and sand were analyzed to determine grain-size distribution. The results are given in the form of histograms (Fig. 8).

The total amount of rock debris eroded from the watershed and deposited on the streets and private property in Montrose and La Crescenta was tremendous. From a rough survey in which numerous measurements of thicknesses were made the writer estimated that no less than 700,000 cubic yards of sediment were deposited in this area. Most of the north-south streets were filled with boulders and coarse gravel to a moderate depth of six inches or a foot, but the east-west streets, which acted to retard the velocity of the flow, received a greater thickness of sediment and usually finer grades. Lawns and the floors of houses along the main currents were covered from several inches to several feet. The thickest sediment occurred back of obstructions in the currents such as culverts, where twelve feet were measured at one point.

The total amount of sediment deposited on Pickens and Halls fans would equal a 2½-inch film of soil taken from the watersheds of the canyons. Of course, it is not intimated that any such uniformity of erosion took place: aerial photographs and an examination of the ground indicated that gullying, soil slides, and the like characterized the erosion of the watershed.

Causes of the Flood

Flooding by either stream torrents or mudflows and consequent sedimentation are the normal process of the building up of an alluvial fan. In this building process there are periods when the stream, insuf-

[5] Rollin Eckis: Alluvial Fans of the Cucamonga District, Southern California, *Journ. of Geol.*, Vol. 36, 1928, pp. 224–247. According to Eckis the rate of decrease in coarseness from the apex to the outskirts of a fan is more rapid on small fans than on large ones.

ficiently charged with sediment, cuts channels into the fan capable of carrying all normal water runoff. This state may be termed one of quasi equilibrium and depends on a balanced combination of the rate of discharge from the mountain canyon, the amount and type of the

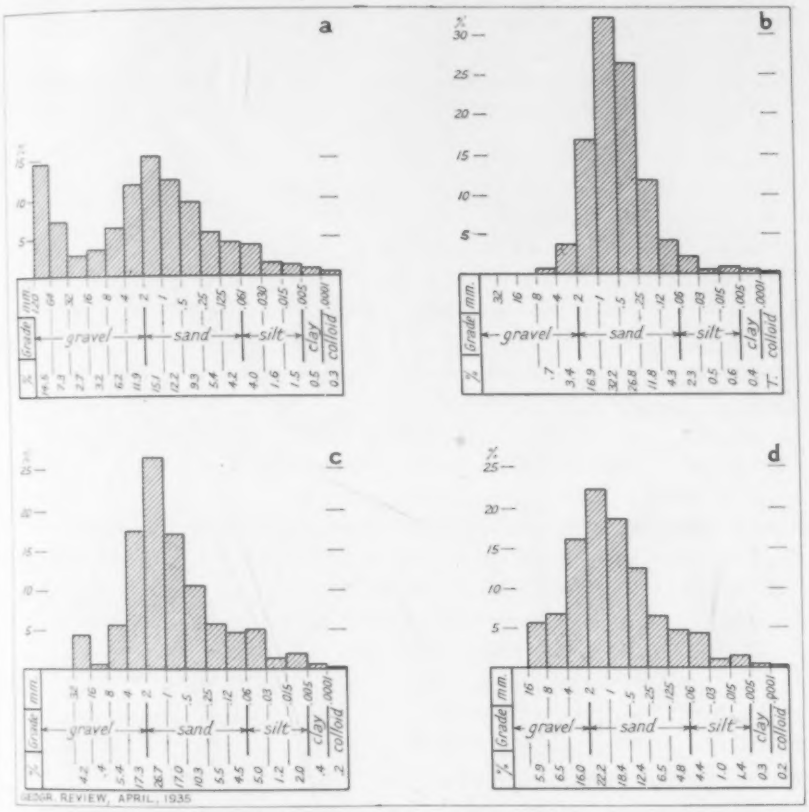


FIG. 8—Histograms of mechanical analyses of select samples from the Montrose flood area: a. Deposit three feet deep in a house on Pickens Wash (see Fig. 6). Boulders up to 18 inches are common in this deposit. It shows the poorest degree of sorting and was likely deposited as a mudflow. b. Fine-grained lense in a rudely lenticular gravel deposit at Pickens Wash and Montrose Boulevard (Fig. 2), probably settled rapidly from turbulent water overcharged with rubble. c. Rudely stratified deposits four feet deep with scattered boulders up to three feet from Halls Wash overflow (Fig. 3). d. Fine-grained lense from culvert deposit at same location as sample b. This material flowed as a viscous mass.

sediment carried, the topography and moisture condition of the fan slope itself, and perhaps other factors. It is not practical here to go into a discussion of all these points, but it is evident that an abnormally large increase in the discharge rate or in the load of sediment carried by the canyon stream may cause overflow and aggradation on the fan slopes. The forest fire of November, 1933, and the unprecedented precipitation of December 30 and 31 produced an excess of available soil and rock debris and a tremendous increase in the normal discharge. The fire, which raged out of control for more than three days, burned

over some 7000 acres of watershed on the slopes of the San Gabriel Mountains immediately draining into the La Crescenta bajada slope. The watersheds of Pickens and Halls canyons were laid bare of vegetation. The forestry service started to plant mustard seed and trees in an effort to furnish a new protective cover, and rock check dams were begun in a number of the canyons; but during the course of the storm

TABLE I—RAINFALL INTENSITIES AT SELECTED STATIONS IN LOS ANGELES COUNTY DURING THE STORM OF DECEMBER 30, 31, 1933, AND JANUARY 1, 1934*

(*In Inches*)

NAME OF RECORDING STATION	MAXIMUM RECORDED PRECIPITATION AT STATED INTERVALS						RAINFALL FOR STORM
	10 MIN.	30 MIN.	1 HOUR	2 HOURS	12 HOURS	24 HOURS	
Griffith Park Nursery	.26	.60	1.15	1.58	5.84	8.36	.....
Flintridge Fire Station	.34	.84	1.33	2.14	9.21	13.19	14.03
Haines Canyon	.27	.50	.94	1.64	6.69	8.17	12.00
Sister Elsie Peak	.30	.50	.88	1.34	5.30	8.07	11.04
Calif. Inst. of Technology . .	.25	.65	1.04	2.18	7.98	8.53	12.97
Opid's Camp (near Mt. Wilson)	...	...	....	....	7.66	13.94	17.93
Wilson Canyon	.53	...	1.06	....	...	.....	.....

* From office records of Los Angeles County Flood Control District.

the incomplete check dams were swept away, and the increasing volume of water and debris overflowed the insufficient fan channels, leaving destruction and rock debris in its wake.

Table I gives the precipitation data for a number of points in the San Gabriel Mountains and other parts of the county. The data for Haines Canyon and Sister Elsie Peak are most applicable, since these stations are located in the burnt-over watershed. To appreciate the effect of the preceding denudation by fire it should be noted that precipitation at these stations was slightly less than in many unburned parts of the San Gabriel watershed of similar topography that incurred only slight damage as a result of the storm. Positive data on the results of deforestation were obtained some years ago in Fish Canyon, whose drainage area is tributary to the San Gabriel River a few miles east of Pasadena. These data show that the maximum peak discharge rate after the devastating forest fire of 1924 in that region was sixteen times the maximum daily rate—about eight times the ratio for a similar rainfall before the protecting forest cover was removed.[6] This increase in peak discharge was due not alone to increased runoff of water but to an increase in volume of debris as well. The enormous increase in fluid volume due to deforestation by fire was undoubtedly the most important cause of the flooding on the Montrose-La Crescenta bajada slope and the Glendale alluvial fan.

[6] W. G. Hoyt and H. C. Troxell: Forests and Stream Flow, *Proc. Amer. Soc. of Civil Engineers*, Vol. 58, 1932, pp. 1037–1066.

Careless engineering and planning contributed to the causes of the flooding, perhaps more through ignorance than through willful neglect. Almost all the bridges and conduits in the affected area were built with waterways of smaller diameter than that of the natural drainage channels they occupied. In many instances these constrictions were the focuses for the spread of storm waters. Filling and diverting the natural drainage channels to make additions to salable lands not only obstructed the channels but led eventually to the building of many homes in dangerous locations. These conditions contributed to cause a large loss of life and property in the flood.

Protection Against Future Floods

With the increasing use of the mountains for recreational purposes fire prevention has become an important problem and one that has received much attention from forestry officials and the public-minded citizenry of Los Angeles County. It might be said that there is no satisfactory way to prevent fires without the complete coöperation of the thousands of people who frequent the mountains during the summer and fall. Under any conditions, in dry seasons, and particularly in dry years, the forest-fire danger is ever present and any outbreak is difficult to control. To protect property and accommodate abnormally large storms, various flood-control works such as dams in the mountain canyons, enlarged storm drains, and debris basins[7] have been placed throughout the county, largely through the efforts of the Los Angeles County Flood Control District. But this work is expensive and does not keep pace with the development of new subdivisions. Although plans had been laid for the building of storm drains and other flood-preventive works in the Montrose–La Crescenta area, the money had not been available for the work. There was no one to predict that a combination of burnt-over watershed and a rainfall heavier than any known here before should so soon occur to flood this populous area whose preparation for such a combination of events was woefully inadequate. Now belated preparations are being made for the immediate building of enough debris basins and storm drains in the area. In the last analysis, however, it should be realized that in southern California every dry wash is potentially a mountain torrent. It behooves every prospective purchaser of property and every resident to be certain that the property in question would not be in a dangerous position in the event of a storm of exceptional intensity in the mountainous watershed.

[7] A "debris basin" is a settling basin excavated at the canyon mouth in which the coarser sediments remain and from which the water passes on into the fan channels.

THE FOREST AND WOODLAND REGIONS OF WISCONSIN

Loyal Durand, Jr., and Kenneth Bertrand

THE forest land of Wisconsin has always presented a distinct regional aspect. Originally the northern part of the state was covered with mixed hardwood and coniferous forests, with interspersed solid stands of pine. This area lies in the short-summer phase of the humid continental climates (Köppen Dfb). The same forests covered the Door Peninsula and the cool littoral along Lake Michigan south almost to the present site of Milwaukee. Southern, eastern, and western Wisconsin were originally part of the great hardwood forest of the eastern half of the northern United States. These parts of the state lie partly within the humid continental long-summer type of climate (Dfa) and partly on the transitional margin from Dfa to Dfb. Originally a few small enclosed prairies, outliers of the adjacent Illinois and Iowa prairies, were found in the present southern and western border counties.[1]

The original mixed forests of northern Wisconsin ordinarily grew on clay or loam soils, whereas the solid stands of white and Norway pine were more largely confined to the sandy outwash plains. During the middle of the nineteenth century only the white pine of northern Wisconsin was of commercial value, except where settled districts had approached the margin of the forests. About these areas, especially near Lake Michigan and Green Bay, hemlock and hardwoods were cut. The cutting of the northern forest in Wisconsin progressed to its heyday in the 1890's and a general close toward 1910, and all but the poorest varieties of trees fell before the lumberman's ax. Even these were destroyed in the slashings or burned by repeated fires. The original fundament of the north has been replaced by a "cutover landscape."[2]

Today the regional distribution of forest and woodland within Wisconsin is quite different from its initial pattern. The thirty million acres of original forest land, 84 per cent of the state's area, have been reduced to about sixteen million acres, only two million of which are estimated to carry timber of commercial value.[3] The state Tax Commission assesses woodland either as "timberland" or in a general category known as "marsh, cutover, and wasteland." The two maps (Figs. 1 and 2) show the present distribution of these types within

[1] Compare the map of the natural vegetation of Wisconsin, 1882, by T. C. Chamberlin in "Geology of Wisconsin," Atlas, Pl. IIA, 1883, and also the map of forest types, Figure 4 in "Forest Land Use in Wisconsin," Report of the Committee on Land Use and Forestry, Madison, 1932.

[2] The term "cutover" is commonly used within the lake states to include anything from second-growth timber to slashings, burned-over country, stumpy country, etc.

[3] Report of the Interim Committee on Forestry and Public Lands, 1929, p. 6; *State Conservation Commission Biennial Rept.*, 1926, p. 38.

Wisconsin and give a representative picture of much of the upper Great Lakes region. The correlation between these forest and woodland areas, the five major physiographic regions of the state,[4] the twenty-two geographic regions,[5] and the population provinces[6] is quite marked. It is not the intention of the present paper to point out all the detailed relationships but to sketch the broader regional aspects of the woodland elements of the landscape.

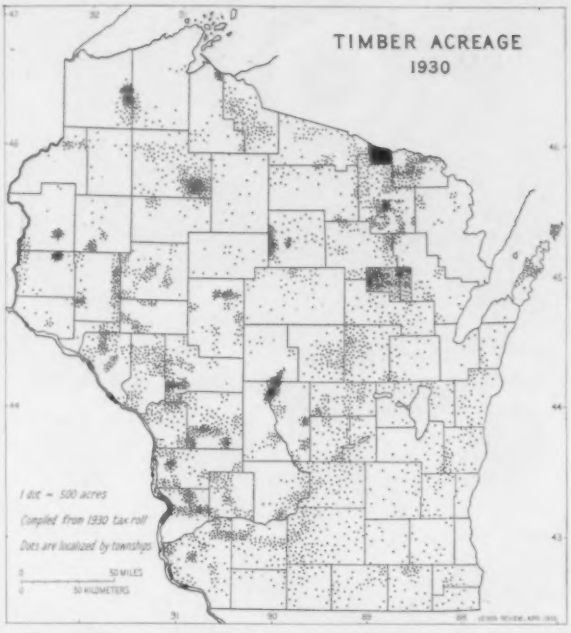


FIG. 1—The commercial timberland of Wisconsin. The scattered stands of commercial timber over the state are farm woodlands assessed as of commercial value or small remaining stands of northern timber. Because most southern Wisconsin woodlands are assessed as cutover land or pasture, many partially wooded areas do not appear on the map. Scale of map 1 : 6,250,000.

REGIONS OF COMMERCIAL TIMBER

Four general regions containing assessed timber of commercial value may be recognized; three of these are isolated remnants of the original northern forests, and the fourth is within the Wisconsin Driftless Area (Fig. 1). The Northeastern Area of Commercial Hardwood Timber is practically confined at the present time to Forest County (Fig. 3). It occupies land of the high, glaciated, short-season Laurentian Upland and lies in a section that has been relatively less accessible than other parts of the upland. However, a government forest reserve has been recently established within part of the area, and the situation is changing. As in most other parts of northern Wisconsin, considerable work has been done here by the Civilian Conservation Corps and the Wisconsin State Conservation Commission.

[4] Lawrence Martin: The Physical Geography of Wisconsin, *Wisconsin Geol. and Nat. Hist. Survey Bull. No. 36, Educ. Ser. No. 4*, 1916; 2nd edit., 1932. Map reproduced in *Geogr. Rev.*, Vol. 18, 1928, p. 405.

[5] Loyal Durand, Jr.: Geographic Regions of Wisconsin, in "Wisconsin Dairying," by W. H. Ebling and others, *Wisconsin Crop and Livestock Reporting Service Bull. No. 120*, 1931. Map reproduced in *Geogr. Rev.*, Vol. 23, 1933, p. 135.

[6] Guy-Harold Smith: The Populating of Wisconsin, *Geogr. Rev.*, Vol. 18, 1928, pp. 402–421.

FIG. 2—Marsh, cutover (in regional usage it is commonly written "cut-over"), and waste land of Wisconsin. Compare Figure 1.

The Sawyer-Ashland-Iron Area of Commercial Timber is likewise a relic of the lumber era. Within this area, as in most of the upper Great Lakes region, the site occupied by a forest is often a result of land-ownership factors. Some companies cut their woodlands as rapidly as possible, others have held reserves, and still others have maintained operations over a longer period by selective cutting. Some companies with an especial eye to future land values did not completely denude their holdings but left virgin timber along the lake shores and thereby greatly enhanced the value for resort property.

Man-made boundaries enclose the third large remaining area of northern timber within the confines of the Menominee Indian Reservation. Historical accident and a watchful government have been factors in the preservation of this patch of northern wilderness, though marked changes are occurring within the reservation at the present time.

The fourth area of commercial timber lies in the hardwood section of the rugged parts of the Wisconsin Driftless Area in western and southwestern Wisconsin. Farm woodlands occupy many of the steep ridges and valley sides of the unglaciated portion of the state, and from these woodlots come considerable but scattered quantities of saw logs. The commercial aspect of the Driftless Area woodland is of regional importance within the state, though the timber is scattered over a wide territory. For many farmers of the Driftless Area the sale of wood is a source of cash income. It is sold chiefly as firewood. Many small manufacturing establishments, particularly cheese factories within the area, burn wood almost exclusively.

Elsewhere within Wisconsin there are scattered stands of assessed commercial timber. Many of the local woodlands are related to

environmental features, such as the Kettle Interlobate Moraine, steep sides of drumlins, or escarpment faces of the cuestas.

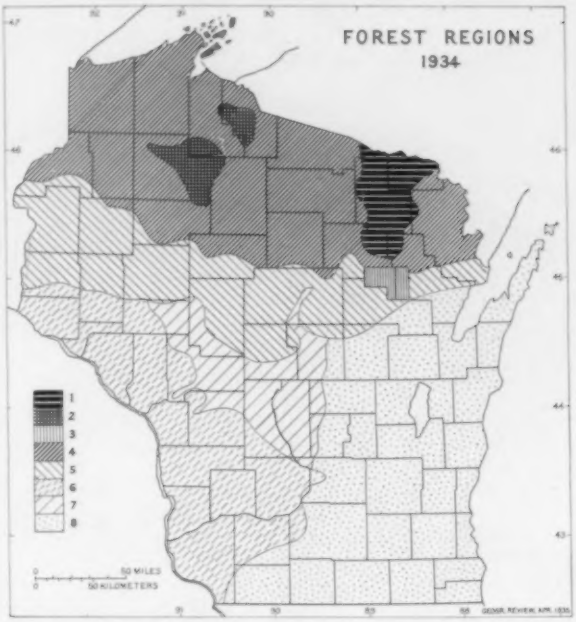


FIG. 3—Forest regions of Wisconsin. 1, Northeastern Area of Commercial Hardwood Timber; 2, Sawyer-Ashland-Iron Area of Commercial Timber; 3, Menominee Indian Reservation Timber Area; 4, Northern Wisconsin Cutover Region; 5, Middle North Farm Woodland Belt; 6, Driftless Area Woodlot Region; 7, Central Wisconsin Sand Country; 8, Southeastern Wisconsin Woodlot Region.

NORTHERN WISCONSIN CUTOVER REGION

The chief concentration of marsh, cutover, and wasteland is within the northern highland portion of Wisconsin. The regional problems of this part of the state are comparable with those of the entire upper Lakes region, and the territory included within its boundaries has been and still is the object of special attention from government and state experts. The region is one of widespread tax delinquency, with resulting county-owned land.[7] Various agencies are at work upon such problems as consolidation of school districts within the region, the building and maintenance of local roads, public parks and forests, game preserves, reforestation, and problems of the isolated settler.

The wooded, semiwooded, brush, and burned areas of northern Wisconsin represent the heritage from the lumberman. The lack of agricultural development, except along some of the chief transportation lines, means that little of the forest is within farm boundaries. However, protection of the farm woodlands from fire has usually resulted in improvement of their quality. Within the northern country there are tracts of good second-growth maple, birch, hemlock, and some pine, but most of the region is covered with aspen, poplar, jack pine, and other inferior trees. Large areas are fire-blackened stumpy wastes. The term "cutover" has thus come to include a wide variety

[7] The states of the upper Lakes region handle the land problem differently. Wisconsin tax-delinquent land goes to the county after three years of unpaid taxes (changed to five years by the 1933 legislature); in Michigan the land becomes the property of the state; and in Minnesota the state holds the land in trust for the county.

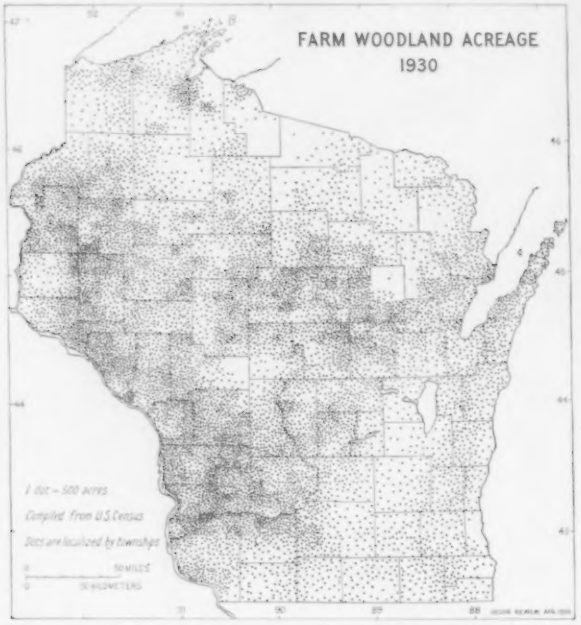


FIG. 4—The distribution of farm woodlands in Wisconsin.

of landscape forms and yet, in the upper Lakes region, connotes a definite landscape picture. On the map (Fig. 2) relatively blank areas may be accounted for by the presence of assessed commercial timber, of clusters of lakes with some resulting agricultural activity dependent on the recreational industry, or of farm communities with considerable cleared land.

The southern edge of the northern cutover region crosses the state in a crescent from Marinette, on Green Bay, to the Minnesota boundary. It corresponds with the population gradient between the north and the better-settled central and southern parts of the state.[8] It marks, very roughly, the southern limit of the Laurentian Upland in Wisconsin and the southern limit of a short growing season of 100 to 130 days. This boundary, apparently fairly well fixed under present conditions, marks the southern limit of the definite upper Lakes region economic problems and of a region handicapped in certain aspects of its natural endowment.

CENTRAL WISCONSIN SAND COUNTRY

The sand region of central Wisconsin, particularly on the western unglaciated side of the terminal moraine, contains the second chief area of marsh, cutover, and wasteland. Much of the marshland lies in the bed of former glacial Lake Wisconsin; the cutover woodlands occupy sandy uplands and islands in the marsh. Some of the marshlands are productive cranberry bogs, particularly southwest of Wisconsin Rapids and in the vicinity of the village of Mather.

Jack pine and scrub oak predominate in the woodlands of the unglaciated portion of the sand country. Much of the wooded terri-

[8] Smith, *op. cit.*

tory lies outside farm boundaries, for farms occupy only a small proportion of this region, and the section has been one of farm abandonment. The State Conservation Commission maintains fire-protection units in the sand country and in other ways recognizes its importance as a timbered area. Various organizations interested in reforestation, particularly some of the paper mills of the Wisconsin River Valley, own tracts of sand land and are developing forest plantations.

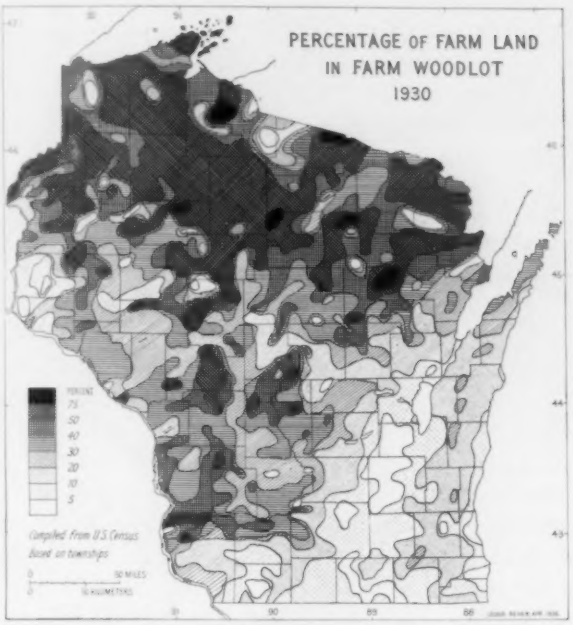


FIG. 5—Isopleth map showing the proportion of farm land devoted to the woodlot in Wisconsin.

THE DRIFTLESS AREA

The steep Driftless Area hillsides are commonly devoted to hardwood woodlots, owned by the farmers of the region. The woodland cover is especially important here in relation to erosion control.[9] These wood lots are assessed as woodland of commercial value or as "cutover" land. However, this so-called "cutover" woodland of the Driftless Area (and of the farming regions of eastern and southeastern Wisconsin) is not at all the cutover country of the northern part of the state and the upper Great Lakes region in general. It is second or third-growth hardwood woodlot of oak, hickory, basswood, maple, and associated trees, not the poplar and aspen-covered country of central sand or northern cutover. Furthermore, different town[10] assessors have different judgments of commercial timber and of "cutover" timber, and this results in a spotty assessment pattern, as the two maps (Figs. 1 and 2) show. Whether from first, second, or third growth, a considerable cut of timber is harvested annually from Driftless Area hillsides. Small sawmills, planing mills, excelsior

[9] Compare the review of "Erosion and Land Utilization in the Driftless Area of Wisconsin" elsewhere in this number of the *Geographical Review*.

[10] As in New England the town is the minor civil division in Wisconsin.

factories, cheesebox factories, and similar manufacturing plants in the valley villages draw their raw material from their own districts.

The dendritic drainage pattern of the unglaciated hilly country of southwestern Wisconsin is reflected by the woodland pattern. The rectangular land survey shows only rarely in the present woodland cover—along a farm boundary of a woodlot or at a corner of a timbered area. Slope and rock outcrop are much more critical in aligning the woodland location, and general physical factors are paramount in the present timber distribution.

In the settlement days of Wisconsin some of the ridges of the Driftless Area, particularly to the south of the Wisconsin River, were prairie lands. The large ridge north of the river forming the divide between the Kickapoo and Mississippi was also a prairie. The landscape of these former prairie areas is today characterized by the planted farm grove and windbreak. The settlers within the Driftless Area, by keeping prairie fires under control or by stamping them out altogether, permitted a more rapid growth of valley-side and valley-bottom brush and woodlands than had been the case under Indian occupance of this region.

Eastern and Southeastern Wisconsin

Eastern and southeastern Wisconsin is an urban-rural area of small to large cities and of intensively developed dairy farms. Included within this region also, from the woodland viewpoint, is the glaciated portion of the Wisconsin sand country, occupied by farms and with characteristic farm woodlands.

The original forest of eastern and southeastern Wisconsin has been completely removed, largely by settlers engaged in the clearing of farm land, though the northern border of the region and the Door-Kewaunee peninsula had a commercial lumber industry. The present landscape is thus characterized by second-growth farm woodlots of two to ten acres in size. A few larger tracts of timber are found, but in general the small rectangular tract is predominant. Farms that have rough moraine, steep-sided drumlins, rocky areas, or steep cuesta-face land within their borders commonly devote this marginal land to woodland. As a rule, however, the woodland occupies a back part of the farm that could be cleared and cultivated should necessity demand. Most of the wooded area of eastern Wisconsin has been returned as "cutover" by the local assessors, though, as in the Driftless Area, the woodland is entirely different from the true upper Lakes cutover of northern Wisconsin.

Farm woodlots account for about one-third (5,717,099 acres) of the present forest land of Wisconsin, and within the state as a whole nearly one-fourth of the acreage within farm boundaries is wooded.

The farm woodlands include most of the elm, basswood, oak, and hickory and all of the walnut of the state, and it has been estimated that at least half of the remaining merchantable timber of Wisconsin is within farm boundaries. Most of this timber is consumed as firewood upon the home farm, but scattered through the region there is limited "commercial lumbering," largely the buying of individual trees or small blocks of timber by wood-using plants.

A belt across the middle north of Wisconsin contains the best farm woodlands of the state.[11] This region lies in the border zone between the sedimentary areas of southern Wisconsin and the crystalline northern highland of the Laurentian area. Within its borders is practically all the present good second-growth white pine of Wisconsin.

[11] F. G. Wilson: The Farm Timberlot, *Univ. of Wisconsin Agric. Exper. Sta. Bull. 407*, 1929, pp. 8–9. This strip is shown on Figure 4.

THE RELATIVE RELIEF OF OHIO

Guy-Harold Smith
The Ohio State University

THE configuration of the surface is one of the most obvious features of any landscape unless obscured by a mantle of vegetation. Whatever agencies and processes may have caused the sculpturing or the construction of the land forms, it is the resulting configuration that is the principal consideration of the topographer and the geographer. The former is concerned chiefly with the surveying and depicting of the surface and the latter with an analysis and interpretation of the landscape features. For purposes of empirical description the configuration may be resolved into the fundamental elements of altitude above sea level or some other datum, degree and direction of slope, local relief, texture, and pattern. Among these elements altitude above sea level has attained a place in geography out of proportion to its importance. The precise altitude of single peaks, for instance, is of far less importance than relative altitude that gives regional character to the physical landscape.

Despite its obvious importance, little attention has been paid to slope in the analysis of land forms, though the ordinary topographic map contains the necessary information for such study.[1] Exception must be made of the detailed topographic and chorographic studies that have lately been engaging a number of American geographers.[2]

It is not possible to cover the whole earth, a single continent, or even a major geographic region with a mosaic of detailed topographic studies; our main dependence must be on larger-scale methods; but if macroscopic methods are to replace microscopic techniques, whatever quantitative devices are available in the investigations should be retained. For the detailed analysis of slope will be substituted an investigation of relative relief that will take slope into account and yet will not require the precise field methods of the surveyor.

Relief is not strictly a function of elevation above sea level, yet there is a relation between altitude and the local relief.[3] The area in the different slope categories is not strictly a function of local relief, yet the differences in elevation between the high and low points in any

[1] See, for instance, J. L. Rich: A Graphical Method of Determining the Average Inclination of a Land Surface from a Contour Map, *Trans. Illinois Acad. of Sci.*, Vol. 9, 1916, pp. 195–199; C. K. Wentworth: A Simplified Method of Determining the Average Slope of Land Surfaces, *Amer. Journ. of Sci.*, Ser. 5, Vol. 20, 1930, pp. 184–194; and the fundamental work of S. Finsterwalder: Ueber den mittleren Böschungswinkel und das wahre Areal einer topographischen Fläche, *Sitzungsber. K. Bayer. Akad. der Wiss. zu München, Math.-phys. Classe*, Vol. 20, 1890, pp. 35–82.

[2] See, for example, the papers by V. C. Finch, "Geographic Surveying," *Bull. Geogr. Soc. of Chicago*, No. 9, 1933, pp. 3–11, and "Montfort: A Study in Landscape Types in Southwestern Wisconsin," *ibid.*, pp. 15–44, also the bibliography on p. 4.

[3] W. S. Glock: Available Relief as a Factor of Control in the Profile of a Land Form, *Journ. of Geol.*, Vol. 40, 1932, pp. 74–83.

area reveal certain slope characteristics. A region of great local relief certainly would have an important proportion of the surface in steep slopes. The character of the underlying structures and the stage in the development of the landscape are surely factors of no little importance. Nevertheless, a study of local relief must involve slope and at the same time reveal significant regional characteristics such as texture of the terrain.

The study of relief may be undertaken by a technique that is more or less objective, though the method about to be described is not without some evidences of subjective considerations. The expressions "local relief" and "relative relief" are used here because the simple term "relief" is not precise enough to convey the fundamental ideas involved. The difference in elevation between the highest and lowest points within a limited area may be regarded as the absolute or local relief of that area. This is essentially the same as Glock's "drainage relief" or perhaps more nearly what Johnson calls "topographic relief."[4] The expression "relative relief" is here used to imply regional comparison; therefore the relation between areas and the delineation of regions with similar relief become important objectives. The map of Ohio is used by way of illustration. The isopleth technique permits the delineation of areas having about the same local topographic relief. The isopleth technique,[5] now a familiar cartographic device, is admirably adaptable to the study of relief. In the accompanying map, Figure 1, it is doubtful whether any other method would portray the relief so vividly, unless a realistic model were prepared with just the appropriate amount of vertical exaggeration.

Previous Studies of Relative Relief

In the large body of literature treating of local relief are very few studies of a quantitative nature. Glock has given us a working definition of relief. He states that "the vertical distance through which rainwash travels on the ground is called the drainage relief and the ratio of the vertical to the horizontal distance covered at the same time is called the drainage ratio."[6] A statistical and cartographic analysis of relief is possible if the implications of this definition are followed.

The earliest publication seems to be Partsch's[7] "Relief Energy"

[4] Douglas Johnson: Available Relief and Texture of Topography: A Discussion, *Journ. of Geol.*, Vol. 41, 1933, pp. 293–305; reference on p. 302.

[5] See Max Eckert: Die Kartenwissenschaft, Vol. 1, Berlin and Leipzig, 1921, p. 11. See also the *Geographical Review*, Vol. 20, 1930, p. 341, for a discussion of the term "isopleth."

[6] W. S. Glock: The Development of Drainage Systems and the Dynamic Cycle, *Ohio Journ. of Sci*, Vol. 31, 1931, pp. 309–334; reference on p. 311.

[7] Joseph Partsch: Schlesien: Eine Landeskunde für das deutsche Volk, Vol. 2, Breslau, 1911, map facing p. 586.

Recently the same method has been applied to all of Silesia. See Walter Geisler, edit.: Wirtschafts- und verkehrsgeographischer Atlas von Schlesien, Breslau, 1932, Sheet 2. (Reviewed in the *Geogr. Rev.*, Vol. 24, 1934, pp. 523–524.)

map of Lower Silesia. Partsch divided his area of more than 10,125 square kilometers into five-kilometer squares represented on the map (1 : 1,000,000) by five-millimeter squares. Seven tints were used to bring out the differences in relief. From his map the proportionate relief in relation to surface can readily be computed, thus:

Relief in meters . . .	0 — 30	30 — 60	60 — 90	90 — 120	120 — 150	150 — 300	300 and over
Percentage of area . .	29	15	19	10	5	12	10

Studies by Krebs[8] include important investigations of relief, in which he used a modified isopleth method. In the two maps of southern Germany and the eastern Alps the lines simply delineate the areas having about the same local relief. On the map of southern Germany (1 : 1,500,000) the eleven different relief provinces are delineated in color. The map, although it does not make rigid use of the isopleth method, does display a regionalism based on relief. On the "Karte der Reliefenergie der Ostalpen" (1 : 2,000,000) seven different relief areas are delineated.

The method used by Partsch has been applied to western Germany by Schrepfer and Kallner.[9] The region is shown on a map on the scale of 1 : 1,000,000, and the area is divided into five-kilometer squares colored to bring out the differences in local relief. The authors call their map a "Kartogramm der maximalen Reliefenergie in Westdeutschland" and thus bring out clearly that the map expresses the maximum, or absolute, relief. As their work covers an area of relatively low relief, they use a varying but small interval.

One of the most recent contributions to the study of relative relief is a paper by Ochocka[10] covering Poland and the adjacent territories of East Prussia, Lithuania, eastern Germany, the High Tatra, and the northern arc of the Carpathians. By the use of isopleths or isarithms and ten tints as many as twenty-two different relief regions are shown. The interval used in the spacing of the isopleths ranges from 10 meters for the nearly flat plains of northern and central Poland to 100 meters for all areas having a relief over 200 meters. The intervals used are successively 10, 15, 25, 50, and 100 meters; the maximum relief, between 1700 and 1800 meters, is found in the High Tatra and in a limited area in the Carpathians.

This map is based on the topographic maps of Russia on the scale of 1 : 84,000, the German maps on the scale of 1 : 100,000, and the

[8] Norbert Krebs: Eine Karte der Reliefenergie Süddeutschlands, *Petermanns Mitt.*, Vol. 68, 1922, pp. 49–53 and Pl. 3; *idem:* Die Ostalpen und das heutige Österreich, Vol. 1, Stuttgart, 1928, map facing p. 40 (Pl. 5).

[9] Hans Schrepfer and Horst Kallner: Die maximale Reliefenergie Westdeutschlands, *Petermanns Mitt.*, Vol. 76, 1930, pp. 225–227, and Pl. 15.

[10] Janina Ochocka: Krajobraz Polski w świetle mapy wysokości względnych (Carte des hauteurs relatives de la Pologne), *Trav. Géogr. Publiés sous la Direction de E. Romer*, No. 13, 1931. (Includes a separate map in colors. See p. 42 for an extended bibliography, largely in Polish.) See also W. L. G. Joerg: The Development of Polish Cartography since the World War, *Geogr. Rev.*, Vol. 23, 1933, pp. 122–129; reference on pp. 125–126. Consult footnotes for bibliography.

Austrian maps on the scale of 1 : 75,000. The area was divided into sections measuring five minutes of latitude by ten minutes of longitude, or about 100 square kilometers. The difference in elevation between the highest and lowest places in each section was plotted on the map, and among these data the isopleths were drawn.

In the basin of the Vistula the local topographic relief is less than fifty meters, but in the morainic areas and along many of the streams it increases slightly. In the Podolian plateau and in Lysa Gora the relief reaches 200 meters in limited areas, and in the High Tatra it reaches a maximum of nearly 1800 meters. The pattern of the isopleths encircling the areas of high relief brings out very clearly the trend of the major lineaments of the terrain. This map displaying only the relief should prove a very useful tool in the investigation of land utilization and other cultural phenomena.

In his regional study of the areas that corner on Basle Burckhardt[11] has included an analysis of the terrain. The local relief is depicted by a system of stippling. The map resembles those prepared by Krebs except that the boundaries are shown only by a change in the spacing of the dots.

The concept of relative relief or, more precisely, relative heights is represented by an investigation of the Carnic Alps by Paschinger.[12] His map is designed to bring out the area of slight relief around Klagenfurt and along the tributaries of the Drava that rise in the central and eastern Alps. The regions of greatest relief are obviously in the interstream areas. The resulting map resembles a contour map except that the isopleths do not represent elevation above sea level but elevation above a local datum.

The Relief of Ohio

The topographic survey of Ohio was completed in 1916 with the issuance of the last quadrangle in 1918.[13] Data were therefore available for construction of a map of the local or drainage relief of the state (Fig. 1). The map presented herewith serves the dual purpose of illustrating the value of the isopleth technique in the quantitative study of relief and of displaying graphically a regionalism in Ohio

[11] G. Burckhardt: Drei Karten der Basler Dreistaatenecke, *Der Schweizer Geograph*, Vol. 11, 1934, pp. 81–92. See also the note elsewhere in this number of the *Geographical Review*.

[12] Viktor Paschinger: Die relativen Höhen von Kärnten, *Petermanns Mitt.*, Vol. 80, 1934, pp. 331–333, 367–368, and Pl. 28. In addition to references to the work of Krebs, Schrepfer, and Kallner, he lists the following papers that should be included in the bibliography on "relative relief": Kurt Brüning: Die Reliefenergie des Harzes, *Jahrbuch Geogr. Gesell. zu Hannover*, 1927, pp. 44–50; Paul Wendiggensen: Beiträge zur Wirtschaftsgeographie des Landes Lippe, *ibid.*, 1931, pp. 121–366; Hans Slanar: Grenzen und Formenschatz des Wiener Beckens, *in* Zur Geographie des Wiener Beckens: Professor Dr. Franz Heiderich zum 60. Geburtstage gewidmet, Vienna, 1923, pp. 1–14; and Marian Sidaritsch: Die landschaftliche Gliederung des Burgenlandes, *Mitt. Geogr. Gesell. in Wien*, Vol. 67, 1924, pp. 118–139.

[13] C. E. Sherman: Final Report, Ohio Cooperative Topographic Survey, Vol. 4, Miscellaneous Data, Columbus, Ohio, 1933, p. 10.

based upon local differences in elevation. The similarities and contrasts in the configuration of the surface are fundamental factors in the differentiation of soils and natural vegetation, and any interpretation of the orographic differences must recognize the regional differences in the geology and the erosional history, which in turn have influenced greatly the utilization of land within the state.

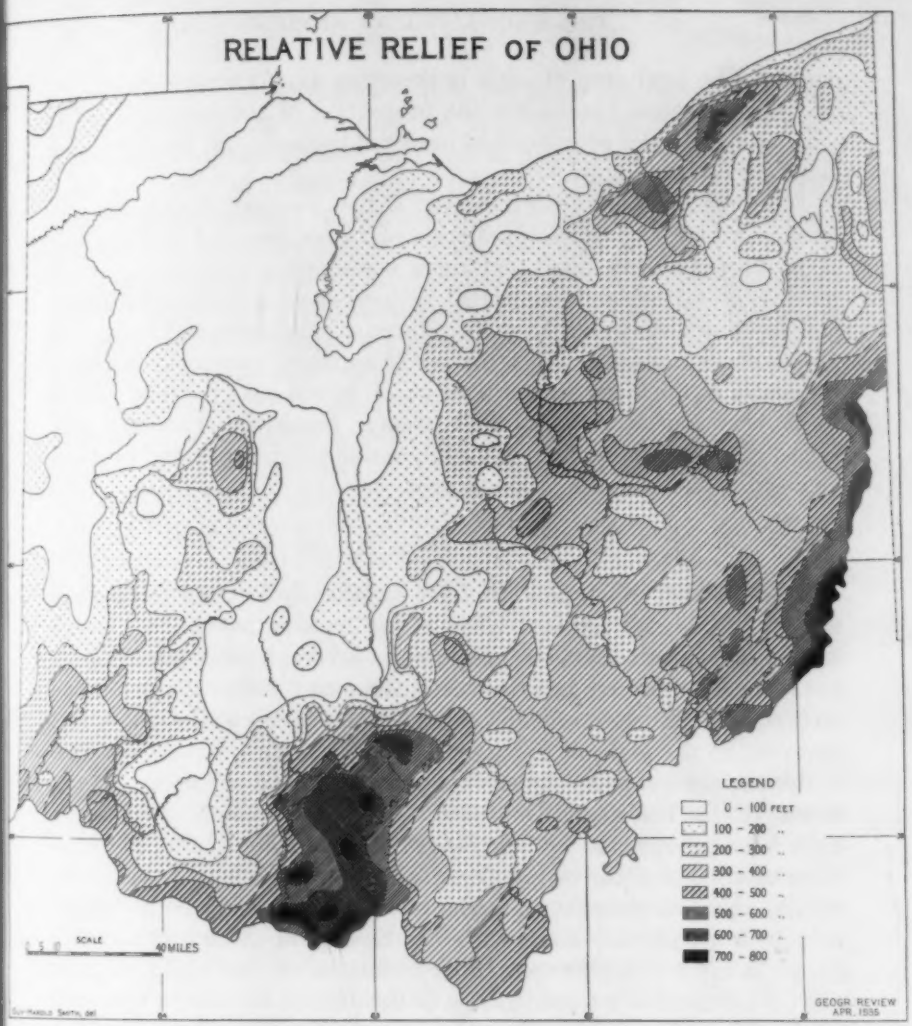
The map of Ohio used for this investigation was on the scale of 1 : 600,000. The area was first divided into rectangular sections to show the location of the topographic quadrangles of the U. S. Geological Survey maps on the scale of 1 : 62,500. By drawing in the parallels and meridians for each five minutes of latitude and longitude these quadrangles were further subdivided into rectangular areas measuring about 4.4 by 5.75 miles. Along the fortieth parallel these enclose 25.3 square miles; in the southern part of the state they contain 25.83 square miles; but along the shore of Lake Erie the area enclosed is reduced to 24.82 square miles. In the construction of the map of Poland Ochocka used areas measuring five minutes of latitude by ten minutes of longitude, or about 100 square kilometers. The 25.3 square miles obtained by use of the five-minute rectangles equal about 66 square kilometers. This should give the Ohio map a slight advantage over Ochocka's map.

For each of the five-minute rectangles the difference in elevation between the highest and lowest points was plotted in the proper area on the base map. This difference represents the maximum relief of each limited area, and the lowest and highest points cannot be farther apart than the diagonal of the five-minute rectangles, or about 7.2 miles. If a high proportion of the points were at this maximum distance, the areas considered would need to be subdivided to get a faithful picture of the relief conditions. Fortunately the high and low points in most of the rectangular areas were relatively close together.

After nearly two thousand values within Ohio and in a narrow zone in the adjacent states were plotted, free curves or isopleths for each hundred feet of relief were drawn on the map. These isopleths delineate areas having about the same local relief and show the relation of each area to adjacent regions of less and greater relief. The completed map exhibits a physical regionalism involving local relief but at the same time shows important relationships; hence the term "relative relief" is used in this connection. This is consistent with the usage of Ochocka for his map of Poland and adjacent areas.

The isopleth map of relative relief permits a measurement of the several areas and thus gives a quantitative statement of the irregularities of the terrain. The area of Ohio as recently determined by Sherman[14] is 44,803 square miles. This includes the waters of Lake Erie and the bays of Maumee and Sandusky, which total 3540 square

[14] Sherman, *op. cit.*, p. 45.



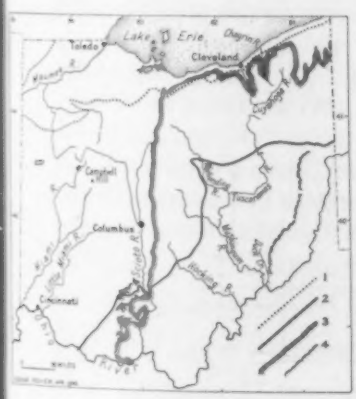


FIG. 1—The relative relief of Ohio. Scale 1 : 3,000,000. The proportion of the state in each relief province is tabulated below.

Relief (ft.)	*Area* (sq. mls.)	*Per cent*
0–100	11,966	29.0
100–200	8,046	19.5
200–300	6,767	16.4
300–400	8,418	20.4
400–500	3,466	8.4
500–600	1,527	3.7
600–700	825	2.0
700–800	248	0.6

FIG. 2—Key map to features mentioned in text. 1, boundary of the Lake Plains; 2, glacial boundary; 3, Devonian-Carboniferous boundary; 4, Flushing escarpment. (2 is based in part on an unpublished thesis by G. W. White: The Pleistocene Geology of the Region of the Reentrant Angle in the Glacial Boundary in North Central Ohio, The Ohio State University, 1933.)

miles. The land area of Ohio is therefore 41,263 square miles. By the use of a polar planimeter the proportion of the total area of the state in each relief province has been determined, and the results are tabulated below Figure 1.

This table should be interpreted with a realization that the map used as a base was drawn on a scale of 1 : 600,000 and that the data were plotted within small rectangles whose sides were spaced at five minutes of latitude and longitude. A closer spacing of the net of meridians and parallels would have introduced a refinement and have given more accurate results. Also, the use of a greater number of isopleths, especially in the large area of least relief, would have made it possible to portray local conditions with greater precision. However, it is hoped that this simple map and explanation will prove useful to others engaged in the analysis of landscapes.

Areas of High Relief

The areas of maximum relief are sufficiently isolated to be designated as distinctive regions. West of the lower Scioto the relief over a considerable area exceeds 600 feet and in several limited areas reaches 700 feet. On the north and the west this region is rather sharply delineated, where the maturely dissected upland gives way more or less abruptly to the plain of low relief. Here the hard capstone of Mississippian age holds up the surface of erosion, and the many streams flowing to the Scioto and Ohio rivers are deeply incised. This area of high relief is regarded by Ver Steeg[15] as an outlier of the Allegheny Plateau surface (Harrisburg peneplain), but Cole[16] inclines to the opinion that it represents a broad interstream area sufficiently reduced to permit its identification with the Lexington (Worthington) erosional surface. The different interpretations of this region of great relief must involve a consideration of its altitude of 1200 to 1300 feet, its elevation of 300 to 400 feet above the well developed erosional surface surrounding it, and its position in respect to the pre-Pleistocene drainage system[17] and the modern Ohio and its major tributaries.

Near the headwaters of the Miamis and the Scioto is a very limited area where the local relief exceeds 400 feet. Within this area is Campbell Hill (1550 feet), the highest point in Ohio. The reasons for the preservation of this outlier of the Allegheny Plateau are uncertain, but it probably is a residual area that escaped erosion because of favorable location in respect to preglacial drainage rather than superior resistance of the underlying formations. The distance from preglacial

[15] Karl Ver Steeg: Erosion-Surfaces of Eastern Ohio, *Pan-American Geologist*, Vol. 55, 1931, pp. 93–102 and 181–192; reference on p. 186.

[16] W. S. Cole: Identification of Erosion Surfaces in Eastern and Southern Ohio, *Journ. of Geol.*, Vol. 42, 1934, pp. 285–294; reference on p. 289.

[17] W. G. Tight: Drainage Modifications in Southeastern Ohio and Adjacent Parts of West Virginia and Kentucky, *U. S. Geol. Survey Professional Paper No. 13*, 1903.

streams, however, was no greater than for many other areas that were reduced. Sharp[18] suggests that the large crown of shale may have preserved this area of moderate relief in a region where the relief is generally low. The maximum local relief is due principally to the dissection of this isolated rock mass, but the minor relief features are related to the moraines festooned about this high point.[19]

In eastern Ohio there is a narrow strip where the local relief exceeds 700 feet. Here the upland surface of the plateau reaches a maximum of 1300 feet. This upland is a westward extension of the Allegheny peneplain of Fridley and Nölting.[20]

The diversion of drainage resulting from glaciation established the Ohio across a western segment of the Allegheny peneplain. The divide between the preglacial Pittsburgh (Grand) and Marietta rivers lay across this narrow strip of high relief. When the ice advanced into the Lake Erie basin and blocked the northward discharge of the Pittsburgh drainage, the old upper Ohio was reversed[21] and the waters were discharged into the lower Ohio. This joining of the Pittsburgh drainage with the lower Ohio permitted the river to incise itself deeply in the Allegheny Plateau and thus produce the present high relief. Deep incision by the master stream and an initially high area are the two important factors in the development of high relief along this section of the Ohio.

To the east of Cleveland and along the northwestern margin of the Appalachian Plateau lies a limited area of high relief. The veneer of glacial drift has given this area a smooth upland surface with a maximum elevation of about 1300 feet. In postglacial times the Chagrin and the Cuyahoga rivers have been deeply incised into the escarpment slope of the Allegheny cuesta. The terrain is distinctly youthful, and the tributaries flow down very steep gradients from the massive interstream areas held up by the Pottsville formation. The coarse texture of the terrain results from the massive character of the underlying capstone now mantled with glacial drift. Dissection has only begun, but the entrenching has produced a local relief of 500 to 600 feet.

Two other areas of high relief in eastern Ohio lie to the west of the deeply dissected area along the Ohio River. The northern is a slightly irregular, roughly linear section trending in an east-west direction. This represents a portion of the Appalachian Plateau that was not glaciated except along the western extension where the local relief has

[18] H. S. Sharp: The Geomorphic Development of Central Ohio (Part 1), *Journ. Sci. Laboratories of Denison Univ.*, Vol. 27, 1932, pp. 1–46; reference on p. 25.

[19] Frank Leverett: Glacial Formations and Drainage Features of the Erie and Ohio Basins, *U. S. Geol. Survey Monograph No. 41*, 1902, Pl. 11, facing p. 304.

[20] H. M. Fridley and J. P. Nölting, Jr.: Peneplains of the Appalachian Plateau, *Journ. of Geol.*, Vol. 39, 1931, pp. 749–755.

[21] T. C. Chamberlin and Frank Leverett: Further Studies of the Drainage Features of the Upper Ohio Basin, *Amer. Journ. of Sci.*, Ser. 3, Vol. 47, 1894, pp. 247–283. See maps on pp. 252 and 253.

been reduced to less than 500 feet. The altitude of the summits in this area is about 1150 to 1200 feet, and the deep dissection by the Mohican-Walhonding and the Tuscarawas, the principal headstreams of the Muskingum, has developed the high relief.

Northward from the mouth of the Muskingum is a second roughly linear area where the local relief exceeds 500 feet. Here Duck Creek and its tributaries flow at an elevation of 620 to 700 feet. High above the valley bottoms the Flushing escarpment holds up the surface to altitudes of 1200 feet, and locally the higher ridges attain an elevation exceeding 1300 feet. It is probable that the Flushing escarpment marks the western margin of the Allegheny peneplain, which to the east of the Ohio River reaches an altitude of 1400 feet.[22] Because of the resistance of the eastward-dipping capstone it may be regarded as the rear guard of the sculptured margin of the Allegheny erosional surface. Its elevation, nearly a hundred feet below the peneplain surface, suggests that it is, in effect, a cuesta outlier that has just failed to maintain the summits at the peneplain level.

Areas of Intermediate Relief

Within the Ohio section of the Interior Lowland the local relief reaches 200 or 300 feet only along the Ohio River where in postglacial times the Miamis have incised themselves into the drift-mantled plain. Here, near Cincinnati, the terrain approaches late youth or maturity, but upstream erosion has not advanced enough to lay bare the preglacial landscape. Only along the master streams and the principal tributaries does the terrain become rugged enough to interfere with agricultural activities. The broad interstream areas have been only slightly dissected, so that an intensive utilization of the land is possible.

Farther eastward relatively large areas within the Ohio section of the Appalachian Plateau have only moderate relief. Although most of the plateau lies beyond the margin of the Pleistocene glaciations, an important section was glaciated and the relief greatly reduced.

The physiographic evolution of the plateau is complicated. Within this region of great diversity the extensive development of the Lexington (Worthington) erosion surface has permitted the subsequent development of only moderate relief. Farther eastward along the Ohio River a higher and earlier surface is represented at an elevation of about 1400 feet.

Although there is considerable variation in the character of the terrain in the unglaciated portion of the plateau, owing largely to local geological conditions, it is generally true that dissection has advanced toward maturity. The terrain is intricately dissected and may be described as fine-textured.

[22] Cole, *op. cit.*, p. 291.

In the area in the southern part of the state, 20 to 30 miles east of the lower Scioto, the well rounded slopes indicate late maturity if we consider the Parker erosional level as our plane of reference. The areas near the Teays and its principal tributaries were reduced to a stage best described as late maturity. Certain of these areas so advanced in their erosional development now lie, as a result of stream diversion, remote from the major drainage lines. In their surfaces the forms of an earlier cycle are preserved, apparently little altered by subsequent vicissitudes.

Farther to the northeast, in areas where erosion has not advanced enough to destroy the Lexington surface, settlement was made both in the uplands and along the bottom lands. In the broad but dissected upland between the Muskingum and Ohio rivers is a large section where the ridge crests are the preferred agricultural areas. Here steep slopes commonly covered with trees separate the upland communities from the valley settlements. In areas of mid-maturity settlements were made in the valleys, with roads and railways following the watercourses closely.[23] In limited areas where erosion has advanced beyond maturity the cultural features are not confined to the lowest areas; for the rounded and gentle slopes permit man's activities and the landscape manifestations of his occupance to advance up the slopes.

Areas of Low Relief

The area of low relief is extensive. In the northwestern part of the state the Maumee plain and adjacent areas have a relief of less than 100 feet except where the plain is diversified by the low moraines and the postglacial valleys that are still in the early stages of their development. This region of slight relief is continued southward on the broad interstream areas, as to the west and east of the Miami rivers. The eastern extension is represented by a triangular outlier to the east of Cincinnati, where it approaches within twenty-five miles of the Ohio River. South of Lake Erie are other limited areas of slight relief, one of which lies on the drift-mantled Appalachian Plateau. The filling of the preglacial valleys with a thick covering of drift has in effect obscured the ancient terrain and created a new surface, whose irregularities are due principally to deposition. The broad uplands and gentle slopes are only slightly altered by postglacial erosion.

Before the glacial invasions of the Pleistocene western Ohio must have been the least rugged part of the state. Here the development of the Interior Lowland had progressed sufficiently along the crest of the Cincinnati arch to expose the easily weathered limestones. The preglacial relief was not great, but an erosional terrain of considerable

[23] Roderick Peattie: The Human Significance of Maturity of a Plains Region, *Journ. of Geogr.* Vol. 25, 1926, pp. 176–183; reference on p. 181.

diversity must have been developed. The continental glaciers so smoothed the surface by the deposition of a veneer of drift and associated deposits that extensive areas are essentially flat. The brief interval of time since the late stage of the Wisconsin glaciation has not been enough to develop an extensive erosional terrain, but when denudational processes shall have diversified and altered the present surface features the relief will not be great.

Relief and Natural Vegetation

The cover of vegetation as it existed at the time of settlement has been investigated by many students, particularly by Sears[24] and by Transeau and Sampson.[25] The map of original vegetation prepared by Transeau and Sampson represents not only detailed studies of the surveyors' records but extensive field investigations. The following remarks are based largely upon their manuscript map.

All the limited prairie areas lie within the regions of low relief in western Ohio. They are, perhaps, the last remnants, rear-guard relics, of the prairie peninsula[26] that once extended well eastward into Ohio. Whatever their origin, Shantz believes that the low wet prairies "were often burned over in late summer or winter, and fires have doubtless been a factor in preventing forest growth on adjacent land."[27] The prairies are not confined to the low, poorly drained lands but are found also in overdrained areas where conditions are favorable to the preservation of the prairie grasses.[28] These latter habitats on which prairie remnants are preserved differ in no essential from extensive areas where forests existed. The problem of the prairies in the humid interior awaits final solution.

Whatever may have been the forest cover of Ohio in preglacial times, it is certain that the invasion of the ice created a habitat that was later to be covered by the beech-maple association. The first trees to cover the glaciated areas were the conifers, and there is evidence that a postglacial dry period facilitated the extension of the prairies eastward into Ohio.[29] The disappearance of the prairie under changed climatic conditions permitted the establishment of the beech-maple association upon the glaciated area where the relief is slight. This was the forest that the first settlers cleared from the land when establishing their farms.

[24] P. B. Sears: The Natural Vegetation of Ohio, *Ohio Journ. of Sci.*, Vol. 25, 1925, pp. 139–149; Vol. 26, 1926, pp. 128–146 and 213–231.

[25] E. N. Transeau and H. C. Sampson: A manuscript map of the natural vegetation of Ohio.

[26] E. N. Transeau: The Prairie Peninsula (Abstract), *Ohio Journ. of Sci.*, Vol. 32, 1932, p. 349.

[27] H. L. Shantz and Raphael Zon: Atlas of American Agriculture, Part I, The Physical Basis of Agriculture, Section E, Natural Vegetation (Grassland and Desert Shrub, by H. L. Shantz), Washington, 1924, p. 16.

[28] Sears, *op. cit.*, Vol. 26, 1926, pp. 128–146; reference on pp. 129–130.

[29] See P. B. Sears: A Record of Post-Glacial Climate in Northern Ohio, *Ohio Journ. of Sci.*, Vol. 30, 1930, pp. 205–217.

In much of southern and southeastern Ohio, where the land is predominantly in slopes, though the relief is not everywhere great, the original forest cover consisted of a great variety of trees referred to as the mixed mesophytic[30] or the mixed slope forest.[31] On the crests of the ridges, where surface conditions permitted a maturing of the soils, the association showed a predominance of oak and chestnut, to cite only one binomial combination. The mixed mesophytic is essentially a slope forest. On flat uplands and along the bottom lands the habitat favored the combination of species commonly dominated by beech and maple.

In eastern Ohio just south of the glacial border the original vegetation consisted of a forest association with a predominance of oak and hickory with chestnut on the crests and upper slopes. This association was the dominant forest of the western slope of the Appalachian Plateau. Westward from Pennsylvania a peninsular extension of this forest has been preserved along the linear area just west and a little south of where the Ohio River turns sharply southward after leaving Pennsylvania. To the north on the glaciated plateau and to the south on the more rounded hills beech and maple were common, but within the oak-hickory area the combination of these two species was of rare and very local occurrence.

This peninsula of oak-hickory, characteristic of the well drained slopes of the Appalachian highland, extended into Ohio where greater relief maintained favorable conditions. Locally fingerlike projections invaded the glaciated area, where the relief is much less, but the extensive gravel deposits of the interlobate moraine facilitated the drainage conditions necessary to the preservation of oak-hickory forest.

The map of relative relief suggested to Transeau[32] the first possible explanation of the oak-hickory area in eastern Ohio. The isopleth technique applied to the study of local relief revealed a significant feature of the habitat not easily discovered by an examination of the topographic maps of the area.

Relief and Land Utilization

The utilization of land for agricultural purposes in Ohio is related to a variety of conditions, such as drainage, slope, soils, water bodies, and markets, and, to a minor degree, to elevation. Waller[33] in his study of plant succession and crop production found that land values

[30] E. N. Transeau: Vegetation Types and Insect Devastations, *Ecology*, Vol. 8, 1927, pp. 285–288.

[31] *Idem:* Progress in the Survey of the Vegetation Types of the North Central States (Abstract), *Annals Assn. of Amer. Geogrs.*, Vol. 20, 1930, p. 45; H. C. Sampson: The Mixed Mesophytic Forest Community of Northeastern Ohio, *Ohio Journ. of Sci.*, Vol. 30, 1930, pp. 358–367.

[32] The writer wishes to acknowledge the kind assistance of Professor Transeau in the preparation of this section of the manuscript.

[33] A. E. Waller: The Relation of Plant Succession to Crop Production, *Ohio State Univ. Bull.*, Vol. 25, No. 9, 1921.

were lowest in the plateau area of southeastern Ohio, where the local relief is greatest and the terrain intricately and maturely dissected. Here also the soils derived from sandstones and shales are low in fertility. Along the valleys are narrow strips of good agricultural land.

The best farm lands are located along the Maumee and Lake Erie plains and in the fertile Miami Valley. Glaciation not only reduced the relief enough to facilitate agricultural activities but also deposited a veneer of drift made up of an important percentage of calcareous material. In this area of good soils about 90 per cent of the land is in farms and 60 to 70 per cent in crops, as compared with only 20 to 40 per cent devoted to crops in the hilly southeastern part of the state. An examination of the series of maps prepared by Falconer[34] reveals that the western part of the state and especially the glaciated area, where the relief is low, are the most valuable agricultural regions.

The census for 1930 showed a continued decline in the rural population over much of Ohio. This reduction affected both the fertile and the poor areas. Within the hill country there are limited areas of good lands, but the rural population, which began to leave the farms as early as 1860, continues to move away.[35] With overproduction of several farm crops the abandonment of the poor lands and their reversion to forests may serve several useful purposes. The dwindling forests may be restored and the damaging floods and soil destruction by erosion prevented.[36]

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[34] J. I. Falconer: Twenty Years of Ohio Agriculture, 1910–1930, *Ohio Agric. Exper. Sta. Bull. 526*, Wooster, 1933.

[35] Guy-Harold Smith: A Population Map of Ohio for 1920, *Geogr. Rev.*, Vol. 18, 1928, pp. 422–427. See also C. Warren Thornthwaite: Internal Migration in the United States, Philadelphia, 1934 (discussed elsewhere in this number of the *Geographical Review*).

[36] H. H. Bennett: The Problem of Soil Erosion in the United States, *Annals Assn. of Amer. Geogrs.*, Vol. 21, 1931, pp. 147–170.

AGROECOLOGICAL EXPLORATION IN THE SOTO LA MARINA REGION, MEXICO*

Basil M. Bensin

THE Soto La Marina region lies on the east coast of Mexico in the state of Tamaulipas about 150 miles south of the Mexico-United States boundary and a little less than that distance north of Tampico. The writer had an opportunity to study the agricultural possibilities of the region for two months from December 6, 1930, to February 5, 1931, as head of a party sent out by the American Slavic Colonization Trust to select places in it suitable for agricultural colonization by European emigrants. The investigation dealt mainly with the agroecological aspects of the region with the purpose of determining the specific crops that could be grown there profitably. The writer believes that the results have value not only because they represent the first study of the kind carried out in Mexico but also because they deal with a region that, by virtue of its accessibility to the markets of the United States, may be looked upon as a potential source for supplies of tropical and subtropical fruits and winter vegetables. It is hoped that this study of a small area may lead to more detailed and systematic studies of tropical and subtropical lands bordering on the Gulf of Mexico from Brownsville to Vera Cruz.

The region examined is in the main a section of a plain rising gently westward from the coast until it merges into the great alluvial fans that spread eastward from the Sierra Madre. It is underlain by unconsolidated material, except that, beginning a short distance back from the coast, a calcareous formation, constituting the zone of carbonate accumulation universally present under the climatic conditions prevailing in the region, has become more or less indurated and forms a strong foundation underlying the upper layers of the soil. Rising above the plain to elevations of generally not more than 300 or 400 feet are a number of isolated remnants of a former higher surface. The Mesa de las Caldas, the eastern end of which extends into the area examined, is a large remnant of a flat-topped mesa. The Sierra de la Cocina, which rises to 500 feet in its highest part and extends southeastward from the eastern end of the Mesa de las Caldas a few kilometers from the Soto La Marina River, has lost its flat-topped mesa form through the thorough dissection to which it has been subjected. It now consists of a rolling to hilly belt underlain by consolidated

*The author is indebted to Dr. J. G. Lipman, Professor A. W. Blair, and Dr. J. S. Joffe of the New Jersey Agricultural College for assistance in the soil analyses; to Mr. Percy Wilson, Dr. J. H. Barnhart, and Dr. J. K. Small of the New York Botanical Garden, Dr. Paul C. Standley of the Field Museum of Natural History, Chicago, and Dr. A. S. Hitchcock of the U. S. Department of Agriculture for assistance in the identification of plants; and to Dr. H. A. Gleason of the New York Botanical Garden and Dr. C. F. Marbut of the U. S. Bureau of Chemistry and Soils for revision of the original manuscript.

limestones and sandstones, all of which are older than the unconsolidated deposits that underlie the surrounding plain. In addition to these large mesas, there are a considerable number of scattered, smaller fragments of the original higher surface designated as *cerrillos*

FIG. 1—The region about the lower Río Soto La Marina, Mexico, showing the agroecological divisions recognized. 1, offshore bar; 2, low coastal strip; 3, plain; 4, hills; 5, river valley; 6, riparian vegetation. The numbered quadrants give the key to the soil samples described in Appendix I. Scale of map approximately 1 : 1,100,000.

if they are considerably longer in one direction than in the other and as *lomas* if small and of about the same horizontal dimensions in all directions.

The valleys cut by the Soto La Marina River and the other smaller streams are not deep. Even along the Soto La Marina no bluffs as high as 50 feet were seen. In most places they were much lower. The Soto La Marina has built an alluvial plain of considerable width, but a large part of it is south of the river and hence outside the region examined. If the agricultural potentialities of the region are ever developed, it is probable that an important part in its transportation connection will be played by the Soto La Marina River, which is now navigable for light-draft vessels up to the town of Soto La Marina and could easily be made navigable to that point for good-sized steamers.

Bordering the plain is a coastal belt consisting of relatively recently laid materials carried down by the numerous streams that reach the sea during the rainy season. For some 50 or 60 kilometers northward from the Soto La Marina River this belt is only a few kilometers wide. From there on it broadens and surrounds an indentation of the sea known as Bahía de los Algolores and Laguna Santa Rita, where it reaches a width of about 20 kilometers. Lying offshore, at a distance of less than one to five or six kilometers, a typical offshore bar, similar to, but less sandy than, the bars of the Texas coast, extends from the mouth of the Soto La Marina to the northern limits of the region. Along the lower Soto La Marina are salty lagoons apparently cut off from the Gulf of Mexico through delta building by the river. Lagoons also characterize the extremely low northern end of the coastal belt.

Important microrelief features of the plain are the *bolsons* or enclosed basin-like hollows of various sizes and depths that dot its surface. They are probably caused by collapse following the solution and removal of the underlying calcareous materials, particularly the supporting layer of indurated lime carbonate. They are important not only because the deeper ones retain water for weeks and even months after the end of the rainy season but also because, their floors being nearer the water table than the surrounding plain, they support vegetation for some time after that of the rest of the region has succumbed to the drought. In a few places the ground water appears on the surface as pools or very shallow wells called *ojos*, such as the Ojo de Agua San Jorge near Malinche Peak. The depth to which wells must be sunk to assure a regular supply of water varies. Usually it is not more than 35 feet and sometimes only 3 to 10 feet. The water is mostly good, but somewhat hard and alkaline. In some places, as at Saladito, it is strongly alkaline, salty, and bitter; but ranchmen and cattle use it without harmful effects.

The underlying rocks of the region are of Tertiary age and belong to the Claiborne group of the Eocene. They consist of sands and calcareous clays, limestones, and sandstones and sometimes contain organic remains. On the flat-topped mesas limestone is often found practically at the surface. Where beds of sandstone are found along the Soto La Marina River and also along the Arroyo de Buenavista, they constitute locally indurated layers of the materials underlying the plain. Thick strata of conglomerates, consisting of sheets of rounded pebbles cemented together by calcareous material, appear in bank cuts on the Soto La Marina and in the beds of some of the smaller streams. Building materials such as sand, limestone, sandstone, and clay are abundant and easily accessible in all parts of the region.

The Soto La Marina region lies within the *tierra caliente*, its average annual temperature being about 75° F. Winter temperatures never fall below freezing. The rainfall decreases westward from the coast

until the Sierra Madre is approached, where it increases again. The driest part of the section between the coast and the Sierra lies somewhat to the west of the western border of the region of our investigations. The average annual precipitation at the town of Soto La Marina is 36.5 inches. At Abasolo, west of the western boundary of our region but only 25 miles from Soto La Marina, it is 23 inches, and at Victoria at the eastern foot of the Sierra Madre it rises again to 35 inches. At the mouth of the Rio Grande the annual precipitation is about 31 inches, and at Tampico 47 inches.

The rainfall is unevenly distributed: there is one rainy season during June and another in September and October, but for somewhat more than half the year practically no rain falls. The effects of so long a period of drought are clearly shown in the type and character of the natural vegetation. One mitigating factor of very great importance to fruitgrowers and gardeners is that the period of maximum cloudiness occurs between November and May, the period of least rainfall, and thus serves to retard evaporation. From October to February the prevailing winds are from the north and are strong and often humid. From April to September the winds blow continuously from the southeast and temper the climate very materially. Finally it should be noted that the region lies in the track of occasional tropical tornadoes.

Land Utilization

Except for a small section expropriated by the government and assigned to small farmers living in the villages of San Vicente and Saladito and a section around the town of Soto La Marina owned by the town and used by its inhabitants for gardens and pasture, all the lands examined belong to two large haciendas. The larger of these, the Hacienda Buena Vista, is owned by a Spanish citizen who lives in Victoria, the capital of the state, and has a resident manager. It comprises about 500,000 acres with the southern boundary along the Soto La Marina River from Guadalupe ranch to Marina ranch. A small separate section around the fishing village of La Pesca also belongs to this hacienda. The residence of the manager is at Buena Vista, and the property includes the ranches of Repelo, La Pastora, Magueas, Miranda, Loreto, Paxtle, Catán, Herradero, La Palma, and San José. The smaller hacienda, El Chamal, is owned by an American who lives on his property.

The chief industry of these two haciendas is cattle raising. A local type of Texas cattle sometimes crossed with Hereford is raised. Before the revolution of 1914 some purebred beef and dairy cattle were introduced into the region by an American farmer who left the country after the revolution; but at present pure breeds are rare anywhere in this part of Mexico. In general the pasture is very poor, an average

of 40 acres being required for each head. In the drought season cactus is much used for fodder, the succulent leaves being fed after the spines have been removed by burning. Hay and grain are fed only to the work and saddle horses.

The cattle are usually marketed when two years old and are sold mostly by the head except at Tampico, where they are sold to the slaughterhouses by weight. The demand of the near-by markets is small, Tampico consuming only 45 head daily and Victoria 65. The chief market now is Mexico City, though formerly the greater number were shipped to the United States. Some cattle are still shipped to Kansas City, St. Louis, and Chicago, but the number has greatly decreased on account of the present high tariff. Another obstacle to the shipping of cattle from Mexico to the United States is the strict inspection for ticks, the source of Texas fever. Cattle for export into the United States must be twice disinfected in a special bath under the direction of a United States government veterinary inspector, and it is reported that the finding of a single tick may mean the rejection of an entire shipment.

Goats are well adapted to the poor pasture and are a common source of meat supply for the ranch population. A few native hogs are raised, some of which have a peculiar united hoof not unlike a horse's hoof—a remarkable adaptation to hilly, stony country. A few chickens are raised for home use only. Some cheese for local use is made of whole cow's or goat's milk and smoked. The common alcoholic beverage is, of course, mescal made from the leaves of the agave.

Corn is the principal food crop grown, and *tortillas* made of corn meal sometimes mixed with acorn meal are a regular part of the daily diet of the ranchmen. Another important item is a local variety of brown bean. Some sugar cane is grown along the Soto La Marina River where irrigation is possible. A considerable amount of henequen was formerly grown; but the plantings have now been abandoned on account of the present low price and an export tax amounting to two centavos a kilogram. Sarsaparilla (*Smilax medica*) grows abundantly in the mountains, particularly in the Sierra de San José de las Rusias south of the river, and forms a fairly important item of export.

On the Guadalupe ranch and the Hacienda San José de las Rusias, south of the river, attempts have been made at irrigation. At the former a steam pumping station capable of irrigating a field of about 10 acres and at the latter a gasoline engine and pump for taking water from the Soto La Marina River were installed a number of years ago. Both of these enterprises have now been abandoned. The cost of such irrigation is estimated at about 100 pesos a hectare.

The nearest railway shipping point is at Victoria, about 70 miles from Soto La Marina on the Monterrey-Victoria-Tampico branch of

the National Railway of Mexico. The National Highway Commission has a highway from Victoria to Tampico under construction, and the road from Abasolo to Victoria has recently been considerably improved for automobile traffic. As a matter of fact, both haciendas use motor trucks to carry supplies from Victoria; but the roads at best are passable only for light trucks, and the general lack of bridges makes it necessary to raft the trucks across the larger streams. Communication between the ranches and even the delivery of mail from Abasolo to the haciendas are by horse and sometimes by donkey.

The hacienda is the center of the ranch life. There the manager lives, and from there the work of the ranchmen is directed. Mail for all the ranches is delivered there, usually twice a week. A store owned by the proprietor, at which the ranchmen receive their rations and purchase other supplies, a school for the ranch children, and in some places a small chapel are there.

The houses of the ranchmen in the Soto La Marina region are usually built of poles from the *tenaza* tree, though some are of clay brick. Roofs are of dry *saquavista* leaves. The houses usually measure about twelve by fifteen feet, and some of them shelter two related families. Such a house costs about thirty dollars to build. The diet of the ranch people is restricted and monotonous. Rations issued monthly by the proprietor commonly consist of 8 liters of corn, 2 liters of beans, 1 kilogram of rice, 2 kilograms of bacon, 2½ kilograms of coffee, 5 kilograms of brown sugar, 1 liter of petroleum, 4 or 5 leaves of tobacco, and 10 pesos in money. White bread is a luxury and is sold only in cities like Victoria and Linares. In fact, the countryside contributes practically nothing to the food of the cities except the few staples that make up the regular diet of the ranchmen themselves. The butter, cheese, and even such vegetables as potatoes and onions, sold in the markets of Victoria and Linares, are largely imported from the United States.

Soils and Vegetation

The soil material of the region is dominantly the product of accumulation by wash from higher areas, or what is generally designated as colluvial material. Most of it has lain in place for a long time, and, on the smooth areas, considerable development has taken place. Large areas are, however, undeveloped or, in Russian soil nomenclature, endodynamomorphic. In addition to the material accumulated by colluvial wash, the soil material in the hilly areas is residual or has accumulated in place through the decomposition of the local rocks. That of the river valleys is, of course, of recent alluvial accumulation. Relatively small areas, except for the offshore bar, have accumulated through the action of the winds.

All the soils are alkaline in reaction, have a low content of organic matter, and, although shallow on the mesas, are elsewhere relatively deep.

As was noted earlier, many small depressions called bolsons are scattered throughout the region. Their soil is usually a sandy loam, darker in color, especially in the subsoil, has greater depths to indurated material, and is usually mixed with small fragments of limestone. These bolsons are very important features of the region, as will be shown by the characteristics of their vegetation.

The depth to ground water is an important matter. On the basis of this depth the relief of the region may be divided into four types: (1) areas with very deep ground-water level, including the flat-topped stony hills; (2) the flat bolsons, where the water table is high; (3) gentle slopes and terraces, where the water is also near the surface; (4) areas near the foothills where ground water appears at the surface, such areas being called *ojos* by the natives. The soils in these types of relief are different.

The soil type usually depends upon the microrelief, and in general the soils of this region cannot be arranged in definite zones; they are azonal or intrazonal by origin, and only in some small degree can they be considered as similar to the soils of arid and subtropical regions as in Central Asia and South Africa. This parallel may be applied to vegetation as well.

Five quite different types of plant formations may be recognized: (1) desert and semidesert thorn and shrub formations, (2) coastal-plain formations, (3) littoral formations, (4) riparian formations, and (5) tropical and subtropical formations. The remarkable feature of these plant formations is that the same plants are present in several formations but with pronounced ecological metamorphic changes; for example, *Randia mitis*, which has here three ecological forms—the tree form in the open valleys, the dwarf shrub on the upland hills, and the cushion type along the seacoast.

Soil types and plant formations are described in the appendixes.

Agricultural Possibilities

The growing season in the Soto La Marina region is practically 365 days of the year; but the fact that the rainfall, although heavy, is unevenly distributed, so that there is a long period of drought, must be the chief consideration in recommending crops adaptable to the region. Irrigation systems could be developed on the Soto La Marina River and also on a number of the arroyos. In the latter case this would mean the construction of reservoirs for collecting rain water during the rainy season. Irrigation for several thousand acres of land in the valley of the Soto La Marina River between Guadalupe

ranch and the town of Soto La Marina, suitable for citrus fruits, sugar cane, and vegetables, could be provided by means of the Arroyo de las Cabras if lifted water could be taken from the main stream at the point where the arroyo empties into it.

For the region in general, however, our recommendation, except for Mexican crops and trees that could be adapted, must be based on a comparison of the combination of climate, topography, soils, and

TABLE I—SOILS AROUND LAGOONS

SAMPLE	SECTION	LOCATION	HORIZON	PRECIPITATION *Ins.*	pH	Cl
21	4	Northern	A	5	7.7	7
21 a	4	Northern	B	1	8.6	8
24	47	Central elevated	A	5	7.0	4
24 a	47	Central elevated	B	2	7.0	4
26	47	Cornfield	A	10	7.7	6
26 a	47	Cornfield	B	10	7.8	7

natural vegetation with those of similar ecological environments in other parts of the world, such as parts of Central Asia, Asia Minor, Turkestan, Australia, and South Africa. Space will not permit full discussion of this comparative analysis, but we can give a list of plants (Appendix III) that we may expect to be successful as far as growth and fruiting are concerned.

APPENDIX I—SOIL TYPES

For the collection of soil samples the region was divided into quadrants of about 10,000 acres each as shown on the accompanying map. Each quadrant was visited for observations in the field, and two samples of soil were taken from each for laboratory analysis and identification, one at a depth of 1 to 8 inches (called Horizon A) and the other at a depth of 8 to 18 inches (called Horizon B). A total of 138 samples were taken at 69 places, 95 per cent from virgin land. Upon the return of the expedition all samples were examined by the author at the New Jersey State Agricultural College.

SOILS OF THE COASTAL BELT

The soils of the coastal belt are divided into three groups on the basis of their physical characteristics and salt content: (*a*) soils around lagoons, (*b*) soils on somewhat elevated parts of the very low coastal strip, and (*c*) soils of the western higher parts of the coastal strip. Table I shows the characteristics of the first group. Sample No. 21, taken from quadrant 4 in the northern part of the coastal belt, is light-gray, heavy, plastic clay, relatively impervious to moisture and carrying a noticeable percentage of chlorine—an indication of the presence of salts. Sample No. 24, taken in the southern part of the coastal belt on Section 47 near the mouth of the Soto La Marina River, is a dark-brown sandy clay containing 50 per cent of clay and a percentage of chlorine lower than in sample No. 21. Sample No. 24 is a better developed soil than sample No. 21, the salts having been leached out to a greater extent. Sample No. 26, also taken near the mouth of the Soto La Marina River, is a gray, very heavy clay, distinctly alkaline in reaction. It precipitates

readily in water because of its structure and the presence of flocculating salts, apparently carbonates. On drying, it forms hard clods. Samples 21 and 26 were taken from the lowest parts of the coastal belt where sea water accumulates after floods; they are saline soils, or *solonchaks*. Sample No. 24, on the other hand, taken on one of the many low mounds scattered over this low coastal strip, belongs to the second subtype, containing lower concentration of alkali and a higher percentage of sand.

TABLE II—SOILS OF LOCALITIES BETWEEN COASTAL BELT AND THE HIGHER PARTS OF THE REGION

SAMPLE	SECTION	LOCATION	HORIZON	PRECIPITATION *Ins.*	pH	Cl
105	39	S. E.	A	8	7.3	7
105	39	S. E.	B	9	7.3	10
117	20	N.	A	6	7.8	7
117	20	N.	B	8	8.0	8
115	26	Central	A	4	7.8	3
115	26	Central	B	5	8.0	5

TABLE III—UPLAND SOILS

SAMPLE	SECTION	LOCATION	HORIZON	PRECIPITATION *Ins.*	pH	Cl
1 a	24	Cultivated, Buenavista	A	10	7.8	6
1 a	24	Cultivated, Buenavista	B	2	7.3	4
5	23	High plateau	A	6	7.8	
5	23	Ranch Repello	B	8	7.8	
16	16	Virgin soil	A	2	7.8	trace
16	16	Virgin soil	B	7	7.3	trace
15	16	Old ranch	A	3	7.6	trace
15	16	Old ranch	B	1	8.0	trace

These elevations are quite characteristic features of the microrelief of this region. Sample No. 26 was taken from a cornfield and shows the possibility of corn culture even on soils containing sodium chloride where carbonates are present.

SOILS OF SLIGHTLY ELEVATED PARTS OF THE COASTAL BELT

On the slightly more elevated parts of the coastal belt farther inland from the coast the characteristics of the soils are different. This is illustrated by sample No. 19 (not shown in tables), collected in the northwestern part of quadrant 13. The structure of the upper horizon becomes looser and much less plastic, whereas the lower horizon remains heavy clay, sticky and plastic when wet and very hard when dry. The alkalinity of both soil and subsoil is still noticeable.

Soils from this region are analyzed in Table II. Samples 105 and 117 are dark brown in color in both upper and lower horizons. They contain about 25 per cent of sand in the surface soil, but the subsoil is still heavy. The structure in the subsoil is lumpy, and limestone fragments are present.

SOILS OF THE HIGHER SURFACES OF THE REGION

The soils of the upland region, as distinguished from those of the low coastal belt and the river valleys, may be divided into three groups: (1) coarse-grained or "skeletal" soils, very shallow, containing large quantities of limestone fragments;

(2) coarse sandy loam of chocolate-brown to dark-brown or reddish-brown color; and (3) fine sandy loam soils, lighter in color than group 2, the surface soil somewhat loess-like in consistency but the subsoil more or less compact. These soils, especially those in groups 2 and 3 have developed from limestones of the hilly regions or from the sandy and calcareous debris of the great colluvial plain forming the larger part of the area. The characteristics of these soils are shown in Table III. Sample No. 1, taken from a cultivated field, is chestnut brown in color; it is made up of coarse

TABLE IV—RIVER VALLEY SOILS

SAMPLE	SECTION	LOCATION	HORIZON	PRECIPITATION *Ins.*	pH	Cl
108	113	Cornfield	A	6	7.3	7
108	113	La Sal	B	6	7.7	8
122	112	Ranch Toro	A	1	7.2	6
122	112	Ranch Toro	B	8	7.9	8
29	27	River Bank	A	8	7.5	5
29	27	River Bank	B	10	7.4	3
43	26	Southeast	A	6	7.6	2
43	26	Southeast	B	1	8.4	4
3	25	Virgin land, Guadalupe	A	6	7.6	3
3	25	Virgin land, Guadalupe	B	5	7.5	2
2	25	Cultd. land, Guadalupe	A	6	7.8	1
2	25	Cultd. land, Guadalupe	B	6	7.8	1

material containing about 70 per cent of sand, the subsoil being lumpy. Sample No. 5, taken from the upland of Sierra de la Cocina in the vicinity of the Ranch Repelo, is dark-brown, fine, sandy loam containing many fragments of limestone. Sample No. 16 is dark-colored sandy loam containing 50 to 60 per cent of sand; the subsoil is lumpy and relatively hard. Sample No. 15 is light-brown sandy loam containing small fragments of limestone, almost structureless in the surface soil but somewhat hard and compact in the subsoil.

ALLUVIAL SOILS

Alluvial soils are found mainly along the Soto La Marina River. Three stretches along the river may be differentiated on the basis of the general character of these alluvial deposits: (*a*) the eastern part nearest the Gulf and partaking somewhat of the characteristics of the coastal belt, (*b*) the central part nearest the Sierra de la Cocina, and (*c*) the western part west of the town of Soto La Marina where the alluvium is more characteristically river alluvium and more uniform than elsewhere. In the middle stretch, the material is made up to a considerable extent of debris washed from the southern end of the Sierra de la Cocina. The soils of the eastern part are generally alkaline and are subject to floods of sea water when the sea runs into the lower river valley because of easterly winds. Table IV shows the characteristics of these soils. Sample No. 108, taken near the mouth of the Soto la Marina, is dark gray in color: the surface soil is friable and contains small fragments of limestone; the subsoil, however, is heavy clay and becomes hard when dry. Sample No. 122 is dark brown in color and in the surface soil is a fine sandy loam in texture. The subsoil has practically the same structure as the surface soil, though slightly heavier in texture and darker in color. Sample No. 43 is a gray clay loam. Samples Nos. 2 and 3, taken in the southeastern part of the region, the former on cultivated land and the latter on uncultivated land in the vicinity of the town of Guadalupe, are alluvial soils of sandy-loam texture. Surface and subsoil are very similar in structure and texture. The virgin soil is light gray in color and the cultivated soil darker, the subsoil of both being darker than the surface soil.

APPENDIX II—PLANT FORMATIONS

Around the mouth of the Soto La Marina River, on the lower land with heavy-clay, saline, impervious soil, is *Sporolobus-Baccharis* formation. *Escobilla* (*Baccharis glutionosa*) could be considered as an indicator of such a poorly drained depression all over the region of the lower Soto La Marina. On the more elevated portion of Long Island are found *Randia mitis* formations, which, since the island is subject to frequent violent winds, develop a cushion-like prostrate type.

On the elevated left bank of the Soto La Marina from the mouth to Guadalupe are thickets of mixed association of mesquite trees (*Prosopis juliflora*), *hierba blanca* (*Croton*), and slender cactus (*Cephalocereus hoppenstedtii*).

True riparian tree formations near the shore line of the river and of the river valley would include *Salicetum nigrae*, *Nolinetum texanae*, *Forestieratum angustifoliae*, *Prosopetum juliflorae*, and *Prosopis acaciopsis-cercidium*. The vegetation of the river shore is, of course, the most luxuriant. The tall willows, called *sauz*, not only beautify the landscape but are useful for building material and for the home handicraft of the natives. Other large trees such as the *olmo* (*Populus arizonica*) and *ceron* (*Phylastilon braziliensis*) are of the same nature and are found scattered along the river. The vegetation of the river valley proper is divided into two parts: the eastern, from the mouth of the Arroyo de la Marina (Sections 45, 46, 47), and the western, extending farther westward to Arroyo de las Cabras (Sections 34, 35, 41, 42, 48). In the eastern part are many depressions of various sizes with poorly drained bottoms. The vegetation of these consists chiefly of the above mentioned *Baccharis* and a grass consocient—*maycio* (*Leptochloa virgata*). The commonest vegetation is small *remera* (*Rumelia angustifolia*) and *pallio* (*Croton niveus*). Occasionally treelike cactus (*Napolea Karwinskiana*) is found.

In the western part of the river valley *Prosopetum* formation becomes dominant. The other consocient trees are *retama*, *huisache* and *anagua* (*Ehretia elliptica*). The bush formations include *panalero* (*Forestiera angustifolia*) with *colima* (*Zanthoxylum fagara*), *anacahuita* (*Cordia boissieri*), and *coyotillo* (*Karwinskia humboldtiana*) 3 to 4 meters high. Occasionally *crucilla* (*Randia mitis*) is found as a small tree 3 to 4 meters high. Among the thickets the slender, cylindrical, virgate-branched cactus (*Lemaireocereus helliannus*) occurs as a consocient. No grass formations are found among the thickets where the soil is completely shaded; but in the open places grasses *Eragrostis beyrichii* and *Aristida purpurea* are found.

The coastal belt, including sections 1, 2, 5, 10, 15, 21, 27, 33, and 40, has quite typical, rather poor vegetation on account of the alkali soils, coastal winds, and gulf breezes. Even at the present time there are possibilities of temporary submergence under sea water after northeast winds. As a result halophytic and dwarfed vegetation prevails around Laguna Madre and the other scattered small lagoons and salt lakes. Dwarfed type (*chorotypus litoralis*) of *Karwinskia humboldtiana*, 50 centimeters high, are quite common there. Pasture grasses are scarce, and only in the western part are there grass associations consisting of *Panicium hallii*, *Hilaria belangeri*, *Cenchrus panciflora*, and *Aristida liebruanni*, the latter being the most important and dominant as part of *Karwinskia-Aristida* associations. In the eastern part of the coastal plain *Baccharetum texanae* interchanged with *Sporobolus* and *Nolinatum lindheimerianæ* is common. *Nolina Lindheimeriana* (*Sachauista*) is found at the river mouth.

Back of the coastal strip the region is divided, from the viewpoint of topography and vegetation, into a number of different areas. These are the lower parts of the plain adjacent to the coastal strip; the slightly higher parts known locally as *altos*, such as Alto de Tio Julio, Alto de Mesquites, and Alto del Mijita; the valleys of the arroyos Buenavista, Bartolillo, de la Marina, and de las Cabras; hills in chains such as Sierra de la Cocina, or smaller, isolated, single hills such as Malinche, Cerrillo del Medio, Loma de Miranda, and Loma del Dormido; and the valleys between these hills. In each such area the character of the vegetation is quite distinct.

Generally speaking, ecologically the vegetation of the lowest part of the plain may be described as thornbush-land. The most common consocients of this thornbush formation here are *bisbirinda* (*Castela texana*), *gavia* (*Acacia amentacea*), *crucilla* (*Randia mitis*), *abrojo* (*Condalia obtusifolia*), *coyotillo* (*Karwinskia Humboldtiana*), and occasionally *sotol* (*Dasylirion sp.*). The bushes of *chaparral* really do not form thickets but are scattered at some distance from each other.

Quite distinct formations of *Leucophylletum frutescentis* are found on rough stony land with shallow residual soils of limestone and should be considered as an indication of the abundance of lime in the soil. *Leucophyllum frutescens* also is occasionally found on alkali soils of the coastal plain, but as a dwarf bush 25 to 50 centimeters high. Other xerophytic shrubs on the dry upland plateaus are *guayacan* (*Parlieria angustifolia*), *pallio* (*Croton torreanus*); the herbaceous xerophytes *hierba del cancer* (*Salvia coccinea*), *manzanilla amarilla* (*Thymophylla berlandieri*), *panarello* (*Marilandium jamaicense*), and *Portulaca parviflora;* and the perennial grasses *Bouteloua hirsuta* and *Bouteloua trifida*. Yuccas and cacti also appear as part of the desert landscape.

In the northern portion of the lowest, eastern part of the plain are several sections where the shrubs had been cleared out and burned. In place of the shrubs there are now grass formations consisting of *Leptoloma cognatum* (*zacate perro*), *Elyonurus tripsacoides* (*zacate liso*), and *Eragrostis beyrichii* (*zacate gramia*), the last being a most important grass in the judgment of local stockmen. The mesquite tree (*Prosopis*) also seems to be a most aggressive successor of the grass formations. Other important plant formations in the depressions with poorly drained bottoms in this section are *Cordietum boissieri, Cordia-Momisia* in the sandy loam depression around Buena Vista, and *Havardietum pallei* and *Crotonetum nivei* in the clay loam depressions. *Tenaza* (*Havardia palleus*) is a tree 3 to 5 meters high that furnishes the chief building material and is considered as a good well indicator.

On the higher western part of the plain, in addition to the formations already mentioned, the shrubs and small trees commonly present are *hierba venada* (*Turnera aphrodisiaca*), *barba chivata* (*Colliandra mexicana*), *revienta cobra* (*Citharexylum Bernandieri*), *heliotrope* (*Heliotropium calcicola*), *cena de leon* (*Pithecolobium dulce*), *ocotillo* (*Gochnatia hypoleuca*), *vara dulce* (*Eisenhardtia polystachya*).

In the valleys between the hills there are trees and shrubs of conspicuously semitropical character, such as *barreta* (*Helietta parvifolia*), *colyma* (*Zanthroxylum fagara*), *ébano* (*Ebonopsis flexicaulis*), *grandillo* (*Amerimmon grandillo*), *drago* (*Pterocarpus acapulensis*), *manzana* (*Ehretia tinifolia*), *manzanita* (*Malphigia ovata*), *anagua* (*Ehretia elliptica*), and *huchacillo* (*Trichilia havanensis*). In the bottoms of some of the valleys near wells where the water table is close to the surface are beautiful high trees of *aguacata* (*Persea gratissima*) and *nogal* (*Hicoria mexicana*). The bright color of this vegetation is a prominent feature of the landscape of the valleys.

Along the arroyos is similar rather mesophytic subtropical vegetation, and in many places the *Prosopetum julifloræ* is dominant, as, for instance, around Arroyo Magueas. Near the Magueas ranch there are conspicuous green bushes of *Cassia sp.* In the arroyo valleys near the coast ball moss (*Tilandsia recurvata*) is quite common on the trees and shrubs—an indication of very high atmospheric humidity. On the elevated parts of the plain, known locally as *altos*, in addition to the *Leucophylletum frutescentis* with its typical bluish-white foliage there are some other xerophytic mixed formations, including *hierba venada*. On the cultivated lands the main crop is usually corn of the dent, semident, and flint varieties, mostly white. Another crop plant is a local variety of bean with brownish seeds, a dry-shelled xerophytic type of bush bean. Around the fields and near the wells on the ranches are often found wild tomatoes (*Lycopersicum cerasiformæ*) with small cherry-like fruits and wild perennial peppers (*Capsicum frutescens*) with small red fruits of very pungent taste—the chili used in many Mexican meat dishes. The natives claim that there are some wild

potatoes, but tubers of this wild potato obtained in Abasolo proved on planting to be ordinary *Solanum tuberosum*. The test was made in Russia at the request of the author by the well known potato specialist S. M. Bukasov of the Bureau of Applied Botany in Leningrad. Pumpkins (*Cucurbita perennis*), either wild or escaped from cultivation, are found in the valleys.

The most troublesome weeds in the fields are the grasses *Cynodon dactylon* and *Panicum reptans*. The nightshade species (*Solanum gracile*) is also found.

Appendix III—Recommended Crops

Potatoes have been found to degenerate in a few years: a very early maturing variety should be used. For bean crops the common Mexican beans, *Phaseolus vulgaris* and *Phaseolus aureus Piper*, and *Phaseolus mungo L.*, an Asiatic xerophytic variety, are recommended. Other possible legumes are lentils (*Lens. esculenta Moench. var. persica*) and chick-peas (*Cicer arietinum L.*).

The present list of field crops could be considerably enlarged by adding some of the early maturing varieties of corn, particularly yellow dent and soft corn, popcorn, and sweet corn, all of which are now unknown in the region. Kaffir corn, durra, proso millet, barley (*Hordeum vulgare, var. pallidum Kke.*), durum wheat, club wheat (*Triticum compactum Host.*, from Armenia), and Turkestan rye (*Secale turkestanicum Bensin*) are also recommended. For forage crops, Bahia grass (*Paspalatum notatum*) and Pará grass (*Panicum barbinode Trin.*) would be suitable for marshy places in the eastern part of the Soto La Marina valley, and for the sections more severely affected by drought Johnson grass (*Andropogon halepensis*, an African perennial), Angleton grass (*Andropogon annulatus*, from India), Natal grass (*Tricholaena rosea*), African rye (*Secale africanum Starf.*), giant Bermuda grass, Rhodes grass (*Chloris gayana*), African Guinea grass (*Panicum maximum*), teff, Turkestan alfalfa, kudzu (*Pueraria Thunbergiana*), lespedeza, a Japanese clover, cowpeas, and sorghum.

Among the oil-producing plants suitable to the region are the sunflower, the castor bean, the soybean, and sesame (*Sesamum indicum L.*), and the following xerophytic types of essential oil producing plants: coriander, salvia, pelargonium, and heliotrope.

Orchards where irrigation could be provided could include all of the citrus fruits, and, in the areas where drought-resisting trees must be considered, pecans, figs, wild apricots (*Prunus divaricata L.*), cultivated apricots (*Armeniaca vulgaris Loam.*), mulberries (*Morus alba L.*), pistacia (*Pistacia vera Mill.*, and especially *Pistacia mutica Fish et Mey*, adapted to dry lime soils in Central Asia), pomegranate (*Punica granatum L.*), olives (*Olea Europea, var. ovalis* or *picholiro* from Asia Minor), almonds from Spain, and quinces (*Cidonia oblongata, var. maliformis Kirsch*, from Central Asia).

Among fiber plants first place should be given to henequen, especially *Agave rigida, Mill. var. elongata*, which takes ten years to mature, *Agave lespinassi, Trelease*, maturing in three years, and also *Agave lechugilla, Torr., Agave sisalana, Perrine*, and *Agave heterocantha Zucc.* All these are adapted to the saline, alkaline, and limy soils of the region on which sotol and yucca now grow. On the lower lands Gambo hemp (*Hibiscus cannabis L.*) could also be grown.

Technical trees, recommended for the valley of the Soto La Marina River, include the China-wood-oil tree or Tung-oil tree (*Aleurites fordi Hemsl.*), the Mu-oil tree (*Aleurites montana Wils.*), Australian tanning acacia (*Acacia decurrens Willd. var. normalis, var. molis*, containing 32 per cent of tannin), Australian golden wattle (*Acacia pynachta Benth.*, 46 per cent of tannin), Australian green wattle (*Acacia deabalta Willd.*, 22 per cent of tannin), and the camphor tree (*Cinnamomum camphora Nees et Eberm*). The following rubber plants are also suggested: *Asclepias mexicana, Asclepias californica, Asclepias galioides*, and *Chrysothamnus consimilis Britt.*

ECONOMIES OF THE LONG-LOT FARM

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IN the economy with which it can be provided with public services, the village farm, characteristic of much of Europe, has an advantage over the isolated farm, typical of most of the United States. The farmers of central and eastern Europe commonly live in villages and go out to work in fields at some distance from the village. In the United States almost the only examples of the farm village are found in Utah. The early Mormon settlements, for purposes of protection and community coöperation, were undertaken as compact villages of farmers, whose irrigated lands were at greater or less distance from their homes in the village; and this form of farm settlement still persists.

The advantages of the compact village-farm settlement in economy of public services are, in part, however, overcome by the time spent in going to and from the fields, which may be several miles from the farmstead. Where livestock are kept and sheltered at the village farmstead and driven to pasture and back each day, as is the case in some of the Mormon farm villages, the time thus spent is considerable.

Between the extreme of completely dispersed farm settlement, with isolated farm dwellings, and that of the compact village type of farm settlement there is an intermediate type that approaches the village type in providing closely spaced settlement yet shares with the scattered type the advantage of having the farmstead on or near the farmed land. This is the well known type of farm settlement associated with the stripwise or long-lot division of land, to be found in much of the province of Quebec. Devised as a means of giving river frontage to a maximum number of owners, it is an equally effective means of making a given length of road serve a large number of farms and has generally been applied to farm settlement in much of the province through the land survey. It is particularly notable in the St. Lawrence Valley and in the lowland surrounding Lake St. John.[1] In this system of land survey the land is first divided into mile-wide parallel strips called ranges. The ranges are in turn divided transversely into lots about one-sixth of a mile wide. The principal local roads are built on the range lines, in most instances on alternate, rather than on all, range lines. Occasional crossroads connecting the range-line roads follow some of the lot lines. Farmsteads usually front on the range-line roads, rarely on the lot-line roads.

With this system of land division, a mile of road including lot-line

[1] R. M. Glendinning: The Distribution of Population in the Lake St. John Lowland, Quebec. *Geogr. Rev.*, Vol. 24, 1934, pp. 232–237.

roads serves on the average about six or eight farms of slightly more than one hundred acres each. Range-line road, which the farmsteads more commonly face, ordinarily accommodates about twelve farms to a mile. In a part of Minnesota where the farms also average about this size a mile of section-line road serves three or four farms.

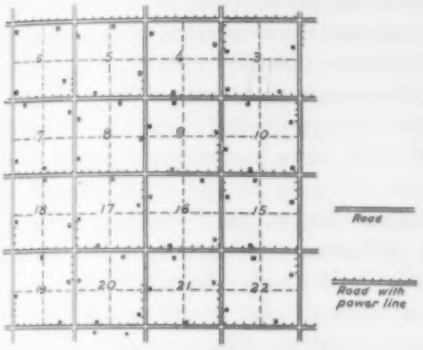

FIG. 1

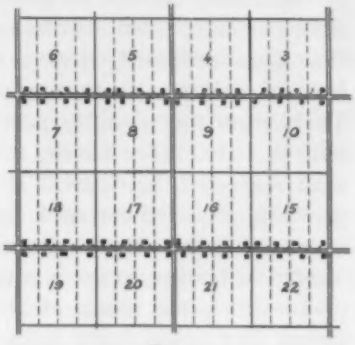

FIG. 2

COMPARATIVE COSTS OF SERVICES

The relative merits of the long and square divisions with respect to public-service costs may be simply illustrated. Figure 1 shows a block of 16 standard sections, with farms 160 acres in size, occupying square quarter sections. Farmsteads are found in each quarter section, and a road follows each section line. This is the type of settlement that, with minor variations, is common in central Iowa. Such a block uses 32 miles of public road. Figure 2 shows the same block of 16 sections with long-lot quarter sections a mile long and a quarter of a mile wide. Roads are built between every two sections instead of between every section and the next, as in the first case. The block of sections now uses only 16 miles of road instead of 32, with but the slightest decrease in accessibility. This reduction in roads would release for agricultural use 128 acres of land now in roads in the 16 sections, assuming roads four rods wide. If we suppose this block of 16 sections to be in a central Iowa county, where the farms average about a quarter section in size and where a road follows every section line, the saving in road mileage by the use of the long-lot farm would be a quarter of a mile to a farm. At an annual cost of maintaining graded dirt road of, say, $80 a mile, the annual saving would be $20 per farm, representing capital value of $333 per farm (at 6 per cent). The land released from roads would amount to 2 acres to a farm, which at $100 an acre amounts to $200 per farm. The gain per farm through smaller road cost and land reclaimed from roads in this section of the country would, under the assumptions of value and cost made here, amount to about $530 per farm. This amount would

not, of course, pay the cost of moving farmsteads to new sites, but it is indicative of the advantage in road economy of the long-lot over the square-lot division in undertaking new settlement. This takes no account of the saving in construction cost of new roads for the settlement.

In electric service the possible economies appear to be even greater than in roads. Farms obtaining electricity from rural power distribution lines ordinarily pay a minimum monthly pole-line charge in inverse ratio to the number of customers to a mile of line. In New York State the monthly pole-line charge ranged from $24 to $33 a mile in 1929.[2] The saving in electric costs in compact, as compared with scattered, settlement is due not only to the shorter length of pole line required for each customer but to the possibility in many instances of serving a number of farms from a single transformer instead of having to use a transformer for every farm served.

In this same block of 16 sections, assuming every farm to be served with electricity from a central distributing system, about 23.5 miles of pole line, or one mile per 2.72 farms, would be necessary to serve the 64 farms distributed as in Figure 1, and as they are so commonly distributed in much of the Corn Belt. At a minimum monthly charge of $28.50 a mile, the minimum monthly charge to each customer would be $10.47. With the distribution of farms as in Figure 2, under the long-lot farm-land division, all the 64 farms could be served by only 8 miles of pole line, or one mile for each eight farms. With a monthly pole-line charge of $28.50 a mile, each farm would pay a minimum monthly charge of $3.56. If the minimum charge in either case were not exceeded, the saving to a farm would be $6.91 a month. Reduction in charge would encourage a more extensive use of the service and thus still further reduce cost to the individual consumer.

Telephone-line mileage could in all likelihood be reduced in about the same ratio as that of power-line mileage. The cost of rural mail delivery and store delivery should be somewhat less. Transportation of pupils to consolidated schools should be facilitated. Fire protection can be more easily provided because of the increased accessibility of the house to centrally located apparatus. Medical services are more readily and quickly available. Community water supplies are more feasible. The difficulty of travel presented by snowbound roads gives close settlement a marked advantage in regions of heavy snowfall.

Farm Operations

The long-lot farm presents both advantages and disadvantages in the efficiency of farm operations, as compared with the square

[2] R. F. Bucknam: An Economic Study of Farm Electrification in New York, *Cornell Univ. Agric. Exper. Sta. Bull. 496*, Ithaca, 1929.

farm. The farmsteads will be located at or near the ends of the farms. If farms of 160 acres, a mile long and a quarter of a mile wide, are divided longitudinally into four long fields, each 330 feet wide, practically no lane will be needed to reach any of these fields from the farmstead.

With the exception of cross-cultivation of a few crops, notably corn, ordinary machine operations, including plowing, harrowing, cultivating, and machine harvesting, can generally be carried on more efficiently in long than in square fields. Since there are fewer furrows, rows, or swaths, when these are run longitudinally, in a long field than in a square field of equal area, less time is occupied in turning at the end of the field.

On the other hand, more fencing is required for long than for square fields. Long fields extending down a slope subject to erosion have some disadvantage in that plowing, harrowing, or cultivating along the contour would have to be done across the narrow field. For this reason long-lot farms whose length extends down an erosive slope might best be divided transversely into a succession of nearly square fields, instead of longitudinally into long, narrow fields. With this division, somewhat more lane is required to reach the farthest field than on the square farms. The mile-long 160-acre farm would need half a mile more lane than the square 160-acre farm. This would reduce the saving in land by the use of the long-lot division to one acre to a farm. Furthermore, the greater distance to the farthest part of the farm increases the time of going to and from the farmstead.

The long-lot farm units need not be uniform, either in size or in shape, but individual units can be made wider or narrower, longer or shorter, to give each operator an approximately equivalent amount of productive or desirable land.

As regards internal farm operation, the long-lot division for agriculture presents certain disadvantages that are at least partially offset by the advantages. Where the disadvantages in internal economy are not too great, the saving in public services the long-lot division makes possible through compact settlement warrants its consideration when new settlement is to be undertaken.

THE SPREAD OF ABORIGINAL MAN TO NORTH AMERICA

Ernst Antevs

THE question of the first peopling of North America has been vigorously attacked in recent years along many lines.[1] According to the best of our belief the findings may be summed up thus: The first man to arrive in North America was of modern type and probably at the Neolithic stage of culture. He came from northeastern Asia to Alaska and probably spread along the eastern foot of the Rocky Mountains where an ice-free corridor had formed some 20,000 to 15,000 years ago. He seems to have reached the Southwest at the age of transition between the pluvial and the post-pluvial epochs, or roughly 12,000 years ago. Reputed older finds need verification.

All the human skeletal remains found in the Americas are, according to Aleš Hrdlička, of modern types, closely resembling living Indians and Eskimos. Neither Neanderthal man nor any other primitive human species seems to have reached these continents. All sure remains of human culture so far found in the Americas are referred to the Neolithic age by most conservative workers.[2] However, many artifacts are believed by some archeologists to be of Paleolithic age. Thus flint artifacts from Cuba and Hispaniola are regarded by Harrington[3] as Aurignacian in type and the Folsom dart points as Solutrean.

Association of Man with Extinct Mammals

Records of ancient man in the form of skeletal remains, dart points, knives, scrapers, fireplaces, etc. have been found in many parts of this continent together with the remains of several large mammals now extinct, such as the mammoth, mastodon, and ground sloth, and of extinct species of bison, camel, horse, musk ox, and antelope. However, even if the associations are real and the first Americans arrived early enough to hunt these animals, they did not necessarily come very long ago; for skeletons of these and other mammals have been found under conditions suggesting that they

[1] A number of specialists discuss the question in an important volume published for the meeting of the Fifth Pacific Science Congress in Canada in 1933, "The American Aborigines: Their Origin and Antiquity," edited by Diamond Jenness with papers by W. A. Johnston, A. S. Romer, N. C. Nelson, E. A. Hooton, Clark Wissler, H. J. Spinden, Erland Nordenskiöld, R. B. Dixon, Franz Boas, and Diamond Jenness, Toronto, 1933.

[2] See N. C. Nelson: The Antiquity of Man in America in the Light of Archæology (Jenness, *op. cit.*, pp. 85–130; reference on pp. 115 and 128), and H. J. Spinden: Origin of Civilizations in Central America and Mexico (*ibid.*, pp. 217–246; reference on p. 224).

[3] M. R. Harrington: Gypsum Cave, Nevada, *Southwest Museum Papers No. 8*, Los Angeles, 1933. This treats the general problem in considerable detail.

survived the last glacial epoch.[4] Thus several of them are represented in deposits formed within the area of the last ice sheet after its withdrawal. It appears that the remarkable extinction of the large Pleistocene mammals essentially occurred during the age of waning of the last ice sheets, the late-glacial epoch, though some mammals died out first during the postglacial. This is a strange fact; for the enormous reduction and southward displacement of the life zones and the resulting overcrowding, disturbance of the biotic balance, and changed conditions of existence throughout practically the entire continent during the approach of the glaciations would be expected to make these early-glacial epochs the ages of extinction.

This time localization of the extinction suggests that it was due to conditions peculiar to the age of the last ice waning rather than to such causes as parasitic diseases or, as held by Tolmachoff, senility or the marked decrease in reproductive power accompanying great specialization.[5] The last age of receding glaciation was primarily distinguished by a rise in temperature, uncovering of land that was quickly occupied by biota, and expansion and northward displacement of the life zones to about the positions they had held before the glaciation set in. In the desert belt the rainfall increased, the moisture being greater than at present until the latter part of the ice waning. Although the known conditions since the climax of the last glaciation do not seem to suggest any special cause for the extinction, this can be due to lack of comparative data; for it is not known how the last late-glacial compares in climatic and other conditions with the late-glacials of the earlier glacial epochs or with the ages of approaching glaciation. The late-Quaternary changes could have been so rapid and fundamental as to upset completely the already disturbed balance of the large mammalian fauna.

Finds Thought to Indicate High Antiquity

A few finds of human skeletal and cultural remains are, on the basis of their geological mode of occurrence, believed by some students to show that man inhabited North America during the early late-glacial of the Wisconsin glaciation or even before this glacial epoch. Thus a find at Frederick in Oklahoma is held by some to be pre-Wisconsin.[6] Although the gravel deposit may be as old as that, there is no evidence or probability that the artifacts found in the large and

[4] A. S. Romer: Pleistocene Vertebrates and Their Bearing on the Problem of Human Antiquity in North America (Jenness, *op. cit.*, pp. 47–83; reference on pp. 67 and 76–81).

[5] I. P. Tolmachoff: Extinction and Extermination, *Bull. Geol. Soc. of America*, Vol. 39, 1928, pp. 1131–1148, reference on pp. 1137, 1140, and 1146, and *Ann. Rept. Smithsonian Instn. for 1929*, Washington, 1930, pp. 269–284.

[6] H. J. Cook: The Antiquity of Man as Indicated at Frederick, Oklahoma: A Reply, *Journ. Washington Acad. of Sci.*, Vol. 21, 1931, pp. 161–167; E. H. Sellards: Geologic Relations of Deposits Reported to Contain Artifacts at Frederick, Oklahoma, *Bull. Geol. Soc. of America*, Vol. 43, 1932, pp. 783–796.

deep pit are equally ancient. They were not seen in place by a trained observer. They could have fallen from the surface of the gravel terrace and later been buried by talus, or they could have been "planted" in a prank to deceive the finder.

Near Cumro in central Nebraska a Yuma blade was found in 1929 between loess beds believed to be of Peorian age.[7] Near Signal Butte artifacts of Yuma and Folsom types have been located in a gravel deposit dated as immediate pre-Wisconsin or Wisconsin. And in about 12 specific places in western Nebraska the same kinds of artifacts were recently discovered in an old soil zone at the base of deposits classified as Peorian. The latter artifacts occurred in association with mammoth, bison, and remains of other extinct vertebrates.[8] The supposed high antiquity of the Cumro find has been questioned by Bell and Van Royen.[9] The Peorian epoch in Iowa and Nebraska falls between the first climax of the Keewatin ice sheet, which deposited the Iowan drift, now included in the Wisconsin glaciation, and the last culmination of the Keewatin ice in the Des Moines-Dakota ice lobes, which deposited the Mankato drift,[10] i.e. it comprises roughly the time from 55,000 to 25,000 years ago.[11] However, the remarkable technique of the Folsom point-Yuma blade complex, so I am informed by Mr. Edgar B. Howard, recalls the Solutrean (about 15,000–13,000 B.C.) and, still more, some Danish (about 3000–2000 B.C.) and Egyptian Neolithic flake work. Thus if the dating of the Nebraskan finds were correct, it would carry with it the unreasonable implication that early man here produced these beautiful points and blades at a time when in Eurasia Neanderthal man of the Mousterian epoch was able to manufacture only the crudest kinds of points.[12]

A spearhead found in association with elephant or mastodon bones in the Walker River canyon, Nevada, occurred in a thick clay bed that included "strata of sand and gravel which . . . in many places form contorted and folded layers."[13] The disturbances may

[7] Bertrand Schultz: Association of Artifacts and Extinct Mammals in Nebraska, *Nebraska State Museum Bull. 33*, Vol. 1, 1932.

For Yuma and Folsom artifacts see the papers by E. B. Renaud, "Prehistoric Flaked Points from Colorado and Neighboring Districts," *Proc. Colorado Museum of Nat. Hist.*, Vol. 10, No. 2, 1931, and "Yuma and Folsom Artifacts," *ibid.*, Vol. 11, No. 2, 1932.

[8] A. L. Lugn: Geologic Evidence Bearing on Pleistocene Man in Nebraska, *in* Preliminary List of Titles and Abstracts of Papers, 47th Annual Meeting, Geological Society of America, Rochester, 1934, p. 58.

[9] E. H. Bell and William Van Royen: An Evaluation of Recent Nebraska Finds Sometimes Attributed to the Pleistocene, *Wisconsin Archeologist*, Vol. 13 (N.S.), No. 3, 1934, pp. 47–70.

[10] G. F. Kay and M. M. Leighton: Eldoran Epoch of the Pleistocene Period, *Bull. Geol. Soc. of America*, Vol. 44, 1933, pp. 669–673. A. L. Lugn (Outline of Pleistocene Geology of Nebraska, *Nebraska State Museum Bull. 41*, Vol. 1, 1934, pp. 319–356, reference on pp. 325 and 351) holds that the Iowan drift represents a separate glaciation and that the Peorian is a true interglacial.

[11] G. F. Kay: Classification and Duration of the Pleistocene Period, *Bull. Geol. Soc. of America*, Vol. 42, 1931, pp. 425–466; reference on p. 465.

[12] G. G. MacCurdy: Human Origins, 2 vols., New York and London, 1924, Vol. 1, pp. 134, 136, 139, and 141.

[13] I. C. Russell: Geological History of Lake Lahontan, a Quaternary Lake of Northwestern Nevada, *U. S. Geol. Survey Monograph No. 11*, 1885, pp. 140 and 247.

mean landslides: this would make the find worthless. The silt in which a human skeleton was found at a depth of 9¾ feet, three miles north of Pelican Rapids, Minnesota, is varved silt deposited in front of the melting Wisconsin ice sheet.[14] However, both a sample of the silt and photographs, which the writer has seen through the courtesy of Dr. G. A. Thiel, show that the silt bed is disturbed, and this raises the probability that the person was buried by a landslide long after the formation of the silt.

These and other finds deserve further study; but none of them appear to furnish conclusive proof of a great antiquity of man on this continent.

Geology and the Peopling of North America

Since the studies in anthropology, archeology, paleontology, and geology either indicate that man first reached North America after the climax of the last glaciation or have failed to show that he arrived earlier, and since the peopling must have taken place from northeastern Asia through Alaska and the glaciated regions of northwestern North America,[15] the geologic and climatic history since the culminations of the last Pleistocene ice sheets—the late Quaternary—may help to fix the probable age of arrival of the first men on this continent. This subject is ably treated by W. A. Johnston.[16]

During the last glaciation the entire mainland of northeastern North America north of a line from New York City through Cincinnati, Madison, St. Paul, and Des Moines was buried beneath ice, only a number of high mountains in Canada forming nunataks. The western edge of this Laurentide ice sheet (the combined Labrador, Patrician, and Keewatin ice sheets) extended through the northwestern corner of North Dakota northwestward into Canada and lay well to the east of Edmonton. North of Edmonton the boundary of the ice is not well known. On the one hand, northern Alberta appears to have drained northward at an early date in the late-glacial age; on the other hand, the direction of young striae suggests that the center of the Keewatin ice during its late climax lay over Great Slave Lake, i.e. rather far west. It is therefore probable that the edge of the Keewatin ice joined the Cordilleran ice near the Rockies at about the 55th parallel but that an ice-free belt appeared on the western border of the Great Plains and on the lower Mackenzie River soon after the

[14] A. E. Jenks: Pleistocene Man in Minnesota, *Science*, Vol. 75 (N.S.), 1932, pp. 607–608; *idem:* Minnesota Pleistocene Homo: An Interim Communication, *Proc. Natl. Acad. of Sci.*, Vol. 19, 1933, pp. 1–6 (see also *Science*, Vol. 76 (N.S.), 1932, pp. 546–547).

[15] Aleš Hrdlička: The Origin and Antiquity of the American Indian, *Ann. Rept. Smithsonian Instn. for 1923*, Washington, 1925, pp. 481–494; revised edition, 1928.

[16] Quaternary Geology of North America in Relation to the Migration of Man (Jenness, *op. cit.*, pp. 9–45). See also R. A. Daly: The Changing World of the Ice Age, New Haven and London, 1934, and F. T. Thwaites: Outline of Glacial Geology, Ann Arbor, 1934.

ice retreat had begun. The fresh character of the youngest extensive drift on the mountains of western Canada and Alaska indicates that it represents a glaciation contemporaneous with the Laurentide ice sheet.

The surface drift in the broad wedge south of Edmonton between the boundary of the Keewatin ice and the Rockies is distinctly older than the young Keewatin drift, yet it is neither greatly eroded nor deeply weathered. Considering that W. C. Alden and W. A. Johnston include all or part of this drift in the last glaciation, and considering that, according to G. F. Kay and M. M. Leighton, the Iowan drift proper is a deposit of the last glacial epoch, the surface drift of northern Montana and adjacent regions of Canada may also belong to the Wisconsin glaciation. Of greater duration than recently held, the last glacial age may have comprised early expansions of the Cordilleran and Keewatin ice sheets (Iowan drift), much later culminations of the Labrador and Patrician continental glaciers, and renewed climaxes of the Keewatin and Cordilleran ice sheets, which had undergone rather considerable reductions. The late culmination of the Keewatin ice in the Des Moines-Dakota ice lobes seems, from studies of varves and other features, to have occurred roughly 25,000 years before our time.[17]

As was pointed out by Johnston, the earliest possible, i.e. late-glacial, land route from unglaciated central Alaska to central North America led eastward to the Mackenzie and thence southward along this river and the eastern foot of the Rockies. This explains why most of the significant finds of earliest man in the United States have been made on the Great Plains. The trail was probably opened 20,000 to 15,000 years ago. Possibly this route was also open for a short time between the first and second expansions of the Keewatin ice sheet, some 45,000, 40,000, or 35,000 years ago.

As far as known, the region of Bering Strait has undergone no vertical movements in late-Quaternary time. But sea level was perhaps some 200 to 240 feet lower than today during the greatest extent of the Wisconsin-Weichsel-Würm glaciation[18] and about 100 to 120 feet lower 20,000 years ago. Furthermore, since a large area around Bering Strait now stands under less than 30 fathoms (180 feet) of water, there probably was a land bridge between America and Asia during the last glaciation. As the glaciers melted and the sea level rose, the strait formed. Some 15,000 years ago the strait

[17] Kay, *op. cit.*, p. 460; Ernst Antevs: Late-Glacial Correlations and Ice Recession in Manitoba, *Canada Geol. Survey Memoir 168*, 1931, pp. 2, 8, and 33; *idem:* Climaxes of the Last Glaciation in North America, *Amer. Journ. of Sci.*, Ser. 5, Vol. 28, 1934, pp. 304–311.

[18] In response to the removal of water from the ocean to form the ice sheets, the sea bottom probably rose about one-fifth of the thickness of the displaced water (Daly, *op. cit.*, pp. 115, 139, and 147). If a water layer 250 feet thick was removed, as Daly estimates (p. 47), the actual lowering of sea level was about 200 feet. If some 300 feet of water was displaced, as estimated by the writer (The Last Glaciation, *Amer. Geogr. Soc. Research Ser. No. 17*, 1928, p. 81), the lowering was roughly 240 feet.

may still have been narrow. At present it is about fifty miles wide at the narrowest point, but this distance is broken by two islands. The first migrants to reach America probably had watercraft of some sort, but they could have crossed Bering Strait and other waters on ice in the wintertime.

Whatever the extent of the last glaciation in northern Asia, there was a barrier of high glaciated mountains extending in a bow from near the mouth of the Lena River to the Sea of Okhotsk and thence following the shores of this sea southward as well as eastward. Northeastern Siberia therefore may not have become sufficiently easy of access nor enough stocked with game to offer any inducement to man until the glaciers had become considerably reduced.

Thus, as far as known, the land route from central Asia to central North America was opened 20,000 to 15,000 years ago. As the Cordilleran ice sheet decreased in extent, cutoffs were opened along the upper Yukon River and its tributaries, the earliest leading out on the plains via the valleys of the Liard and Peace river systems and a later route leading due south via the Fraser. The Pacific Coast route was also opened for travel by land most of the way. Conditions more or less resembling those now in existence seem to have prevailed on the coast of southern British Columbia for some 8000 to 10,000 years. The water route along the coast was evidently navigable in early late-glacial time but may have been discouraging to the watercraft of that time.

When the route via the Mackenzie delta was opened, the temperature was lower than it is today, and most of the country through which the trail led was tundra in a broad sense. The chief game animals of this late-glacial tundra probably included the caribou, the musk ox, the Arctic hare, and some now extinct mammals. Fish and waterfowl occurred in lakes and rivers. Life for man on these tundras would have been hard and precarious. This can be judged from the uncertain existence of the modern Caribou Eskimos of the Barren Grounds between Hudson Bay and Great Slave and Great Bear lakes and of their Indian neighbors on the edge of the woods. Because of the seasonal migrations of the chief game, the Barren Ground caribou, the Caribou Eskimos, whose territories do not extend to the forests, suffer an ever returning famine during the winter months, while the Indians lead a nomadic life.[19] Although the need for food, clothing, and shelter together with youth's inborn desire for adventure and migration may have been the main reasons for the movements of the ancient peoples, and although Bering Sea surely abounded in seal and other sea mammals and the rivers offered salmon, while the bordering tundra had its usual game animals, the

[19] Diamond Jenness: The Indians of Canada, *Natl. Museum of Canada Bull. 65*, 1932, pp. 386 and 406.

immigrants did not stay on the shores of Bering Sea but spread over Alaska, probably because of both inability to secure the sea mammals and desire to escape oncoming tribes. Once the migrants were in the Mackenzie Valley, food increased and climate improved southward.

As the border of the last ice sheet withdrew in the temperate regions, the coniferous forest began to invade the previously ice-covered land. In the forests of the Mackenzie Valley game was more plentiful and sure than on the tundra, the chief animals being moose, woodland caribou, beaver, bear, porcupine, and bison. In the park steppe to the south of the coniferous-forest belt and in the grasslands of the Great Plains the chief game was bison.

About 9000 to 8000 years ago the temperature at some distance from the ice remnants may have reached the present level. It continued rising and from about 7500 to 4000 years before our day was distinctly higher than now in northern Europe and probably also in North America. Some 3500 years ago it had dropped to its modern level, at which it has since remained except for a somewhat lower stand between 500 B.C. and 800 A.D.[20] The conditions for the spread of man through the Arctic regions of Siberia and Alaska-Yukon may have been least severe and hazardous during the warm age several thousand years ago. It seems probable that most tribes immigrated then, even if the migrations began soon after the route was opened in late-glacial time and have continued up to the present.

In the southwestern states the glacial epoch of the north was matched by mountain glaciation and by an age of moister climate, a pluvial epoch. The last pluvial of the Southwest appears to have been contemporaneous with the last extensive glaciation in the mountains of the region and with the greatest southward displacement of the North Atlantic and the North Pacific low-pressure areas.[21] The early part of the moist period probably did not have heavier precipitation than the present, but the higher lake levels may have been a consequence of the decrease in evaporation that accompanied the temperature drop during the last great ice expansion in western North America. Later the pluvial may also have been connected with the decrease in precipitation over the ice sheets that, together with a rise in temperature, caused the deglaciation. The decrease in precipitation over the ice sheets was probably made up by an increase in rainfall in the desert belts. As the ice sheets and their anticyclones gradually waned, the temperature rose, the North Atlantic and the North Pacific lows migrated northward to their modern sites, and

[20] Erik Granlund: De svenska högmossarnas geologi (with German résumé: Die Geologie der schwedischen Hochmoore), *Sveriges Geol. Undersökning*, Ser. C, No. 373 (Årsbok 26, 1932, No. 1), Stockholm, 1932, p. 169.

[21] Eliot Blackwelder: Pleistocene Glaciation in the Sierra Nevada and Basin Ranges, *Bull. Geol. Soc. of America*, Vol. 42, 1931, pp. 865–922, reference on pp. 889 and 915; Antevs, Climaxes of the Last Glaciation.

the present climatic conditions were ushered in. In the Southwest this probably took place some 15,000 to 10,000 years ago, or somewhat earlier than in the northern states and southern Canada. Since the end of the pluvial epoch proper precipitation in the Southwest has undergone considerable fluctuation and several wet and dry ages have been locally rather pronounced—a fact advising caution in dating finds of ancient man in the region.

However, on the basis of the general knowledge of the climatic evolution some finds of prehistoric artifacts can, it seems, be approximately dated. Examples are the occurrence of distinctive points in association with an extinct bison beneath 8 to 12 feet of clay 10 miles west of Folsom in northeastern New Mexico;[22] of the same kind of dart points and other artifacts in association with quantities of mammoth and bison bones in a blue diatomaceous earth forming the top of old lake beds at two separate places some 15 miles south of Clovis in eastern New Mexico;[23] and of miscellaneous artifacts in association with extinct ground sloth, camel, and horse in Gypsum Cave, 16 miles east of Las Vegas in southern Nevada, in beds composed of material fallen from the cave roof and animal detritus, but underlain by water-borne gravel, sand, and silt. These and perhaps other occurrences seem to point to the age of transition to the post-pluvial and to the earliest part of this epoch, when the moisture was on the decrease but the aridity had not reached its modern intensity. They are, then, the oldest approximately dated finds relating to aboriginal man in North America.

Perhaps equally old but still more difficult to date are the human bones found in association with remains of extinct horse, cave bear, camel, ground sloth, etc. at several levels down to a depth of 50 feet in the Conkling cave, located 14½ miles southeast of Las Cruces and 1¾ miles east-northeast of Bishop's Cap (Pyramid Peak) in south-central New Mexico,[24] and the Folsom point and bones of musk ox and extinct bison found in a bed of charcoal and ashes in a cave on the Rocky Arroyo 33 miles west of Carlsbad in southeastern New Mexico.[25] Surely old and significant finds of artifacts and hearths have been made by Mr. E. B. Sayles and Dr. Cyrus N. Ray near Abilene, Texas, in river terraces that record several distinct climatic and physiographic changes in the region since the arrival of man.

[22] H. J. Cook: New Geological and Palæontological Evidence Bearing on the Antiquity of Mankind in America, *Natural History*, Vol. 27, 1927, pp. 240–247; *idem:* Glacial Age Man in New Mexico, *Scientific American*, Vol. 139, 1928, pp. 38–40.

[23] "Arrowheads Found with New Mexican Fossils," *Science*, Vol. 76 (N.S.), 1932, Suppl.: Nov. 25, pp. 12–13; "Early Man in America," *ibid.*, Vol. 78 (N.S.), 1933, Suppl.: Aug. 18, pp. 7–8. E. B. Howard: Association of Artifacts with Mammoth and Bison in Eastern New Mexico, *ibid.*, Vol. 78 (N.S.), p. 524.

[24] W. A. Bryan: The Recent Bone-Cavern Find at Bishop's Cap, New Mexico, *Science*, Vol. 70 (N.S.), 1929, pp. 39–41. Personal communication from Mr. Roscoe P. Conkling.

[25] See footnote 23.

PRECIPITATION AND TREE GROWTH IN THE HARNEY BASIN, OREGON

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PROBLEMS connected with water supply and its utilization commonly require more data on the general variations and trends of precipitation than is covered by the usual short-time climatological record. The use of tree-ring records in extending the short-time precipitation records is well known.[1] An example in the form of a composite diagram was given in the January number of the *Geographical Review* in reference to the general problem of climatic trends in the submarginal lands of the western United States. A specific instance, obtained in the course of water-supply investigations in the Harney Basin, Oregon, is given herewith.

One interesting feature of this analysis is the use made of the juniper, commonly regarded as offering difficulties to the investigator of tree-ring records.[2] In this case the juniper was selected because the tree grows on the foothills close to the valley floor and at an altitude not far above that of the Harney Branch Experiment Station (4139 feet), where meteorological observations are made.

The species of juniper growing in the Harney Basin tend to branch near the ground and the trunks of the mature trees to become lobate in cross section, so that they have flutings. In many trees the several lobes grow at somewhat different rates, so that the width of a particular annul ring may not be constant. Also, the older trees generally have extensive decayed sections, particularly at the heart or core. For these reasons a considerable number of trees were examined, but sections of only four were found satisfactory for study. These were full sections taken from isolated trees growing well above the bottom of any draw or depression and located as follows:

1. Burns, 6 miles northwest of, on road to Izee. Near rock ledge on steep slope with southern exposure; altitude 4750 feet.
2. Burns, 21 miles west of, on highway to Bend. Sandy soil on flat ridge; altitude 4450 feet.
3. Frenchglen, 1½ miles southwest of, on road to Blitzen. Near the pass from Blitzen Valley into Catlow Valley, on rocky shelf; altitude 4840 feet.
4. Frenchglen, 5 miles north of, on road to Narrows. On steep rocky slope with western exposure on west side of Blitzen Valley; altitude 4600 feet.

Transverse sections two inches thick were cut from the trunks

*This investigation was made by the writer while temporarily employed by the Bureau of Biological Survey. The field work was done in September, 1931, in collaboration with T. W. Robinson of the United States Geological Survey.

[1] A. E. Douglass: Climatic Cycles and Tree-Growth, *Carnegie Instn. Publ. No. 289*, Vol. 2, 1928. Compare also the report "Fifth Conference on Climatic Cycles," *Geogr. Rev.*, Vol. 22, 1932, pp. 492–493.

[2] Douglass, *op. cit.*, pp. 10–11.

about one or two feet above the ground surface, and lines were drawn on each in the position of growth to indicate the four cardinal directions of the compass. In some instances these lines were shifted a few degrees in order to avoid indentations and other defects. Along each cardinal radius every tenth ring was marked and dated, and if possible it was completely traced out. The very small intervening rings of

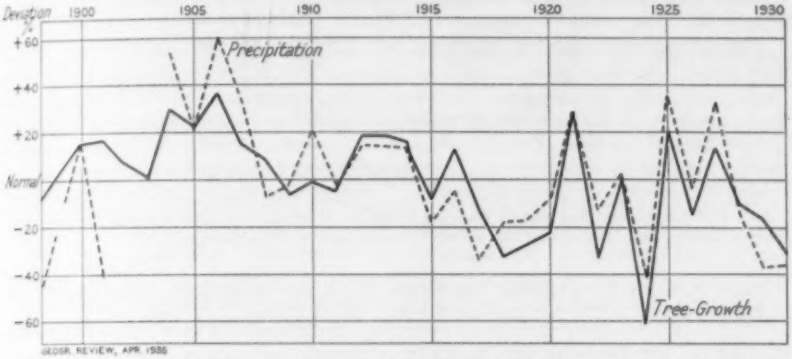

FIG. 1—Graph (unadjusted curve) showing variation of tree-ring widths and precipitation, Harney Basin, Ore.

the four sections were also compared to obviate improper dating from double or missing rings.

For measuring the ring widths a meter stick was fitted with a slide equipped with a fine pointer, a magnifying glass of 14 diameters, a vernier, and a slow-motion screw. The stick was fastened to the tree section so that the pointer could be moved along one of the radial lines, and a reading to 0.1 millimeter was taken at the margin of each ring. Except where decay prevented, readings were taken along each of the four radii, and the four measurements of each ring were averaged.

For each tree the mean width of ring was determined for the period 1760 to 1930 inclusive, and the variation of each ring from this mean was determined and expressed as a percentage. An average of the four results for each year was taken to represent the variation from normal growth.

Rainfall and snowfall records at Burns were started in 1892 and were continued, somewhat intermittently at first, until December, 1921. At the Harney Branch Experiment Station, which is six miles due east of Burns, records were started during the latter part of 1913 and continued up to date. For the period that included 72 months of concurrent records the average annual precipitation at Burns was 9.89 inches, and at the Harney Branch Experiment Station it was 8.03 inches, or 81.2 per cent of the former. By applying this percentage to the earlier records at Burns the precipitation at the Harney Branch Experiment Station was estimated for 1898, 1900, 1901, and from 1904 up to the beginning of the record at the latter station. A climatic year

beginning with October 1 was used. These figures together with the actual records gave 8.6 inches as the mean precipitation at the Harney Branch Experiment Station. The percentage of yearly variation from the mean was determined.

The variations of tree-ring widths and precipitation were then plotted, both without and with adjustment. The former result is shown in Figure 1, the latter in Figure 2. The smoothing process of

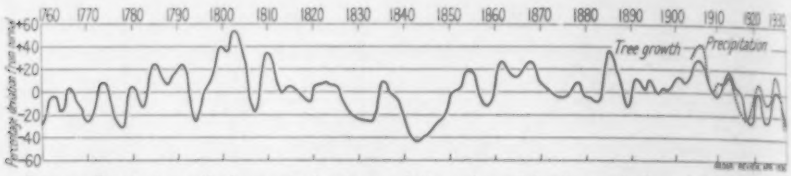

FIG. 2—Graph (smoothed curve) showing variation of precipitation as indicated by tree rings, Harney Basin, Ore. The dotted line shows variation in measured precipitation.

Figure 2, done by graphic methods, took the means of three successive values while giving double weight to the middle one. The close resemblance of the two curves is quite evident.

The graph on Figure 2 extends back to 1760. Two of the trees had rings extending back to 1733, but these results are not given, since two trees are hardly enough to give a representative curve. However, the average of these two trees showed tree-ring sizes below normal from 1755 to 1759 inclusive, and with but two exceptions they were above normal from 1733 to 1754 inclusive.

The mean width for all the annual rings was 0.824 millimeter, the mean for the period 1760 to 1930 inclusive was 0.818 millimeter, and for the period 1898 to 1930 inclusive it was 0.82 millimeter. This would indicate that the mean precipitation at the Harney Branch Experiment Station for the years during which records are available and computed is not materially different from the mean for the period of 170 or 200 years. Although it is evident from the curves that it would not be possible to determine accurately the number of inches of precipitation for some particular past year of no record, yet the correlation appears to be strong enough to indicate rather definitely general trends and variations.

Data derived from this investigation seem to indicate that a precipitation of 8.6 inches is not far from the true mean for the Harney Branch Experiment Station and that severe and protracted droughts may occur at intervals of 70 to 90 years.

SCIENTIFIC EXPLORATION IN NORTHEAST LAND: A REVIEW*

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A. G. Nathorst is responsible for the following anecdote. A. E. Nordenskiöld, in the years subsequent to his more strenuous Arctic exploits, was wont to remark to Nathorst: "When we become old, we'll go on an expedition to Spitsbergen." "But when in later years I jestingly reminded him of the agreement," Nathorst's story continues, "and asked him if he did not think we were old enough now, since his hair had become white and I had lost most of mine, he always laughed and answered 'No.'"

The "Scientific Results of the Swedish-Norwegian Arctic Expedition in the Summer of 1931" are proof that young men can still win laurels in the cradle of scientific polar exploration, the relatively accessible region a Nordenskiöld could scoff at forty years ago. The leader of the expedition, Professor Hans W:son Ahlmann of Stockholm, has told in an earlier account[1] how by taking advantage of phenomenally favorable ice conditions the expedition was able to make full use of the field season and how its scientific program was carried out with clocklike accuracy. The region visited includes Northeast Land—the second largest of the islands constituting the Svalbard archipelago—several of the smaller islands lying north of Spitsbergen and north and east of Northeast Land, and the waters between Svalbard and Franz Josef Land.

Sveanor, the expedition's base camp, was on Murchison Bay, in latitude 79° 56.5′ N., longitude 18° 18′ E. A fully equipped meteorologic station was maintained here, and a continuous record of ablation from a perennial snowbank was obtained. A record of total (sun + sky) radiation, by a Robitzsch actinograph, is a noteworthy part of the meteorologic record. Two mobile land parties operated on Northeast Land—the geological and botanical party, which worked on the ice-free northwestern parts of the island, and the glaciological party, under Professor Ahlmann, which traveled by dog sledge from the south shore of Wahlenberg Bay eastward and northeastward to the eastern edge of the accumulation area of the inland ice, in about latitude 79° 55′ N., longitude 26° 30′ E., and thence westward to the base station. The glaciological party thus traversed the three principal divisions of the inland ice of Northeast Land, named by Professor Ahlmann "South Ice," "East Ice," and "West Ice," as well as the ice-free Rijp District between the heads of Rijp Fiord and Wahlenberg Bay. The maritime party, on board the expedition's ship *Quest*, sailed southward through Hinlopen Strait and eastward as far as Franz Josef Land, returning to Sveanor by a route lying north of Northeast Land.

Parts I to X of the "Scientific Results" are as follows:

I. The Cartography of the Coast-Districts of North-East Land and its Environments, by Hans W:son Ahlmann; II. Determinations of Latitude and Longitude, by L. Rosenbaum; III. The Inland Cartography of North-East Land, by Hans W:son Ahlmann; IV. Special Cartography, by L. Rosenbaum; V. Geomorphology, by Hans W:son Ahlmann; VI. Climatology and Meteorology, by Backa E. Eriksson; VII. On the Total Radiation from Sun and Sky at Sveanor, by Anders Ångström; VIII. Glaciology, by Hans W:son Ahlmann; On the Dependence of Ablation on Air

* Scientific Results of the Swedish-Norwegian Arctic Expedition in the Summer of 1931. Led by Hans W:son Ahlmann. [Introduction and Parts I–X.] *Geografiska Annaler*, Vol. 15, 1933, pp. 1–68, 73–216, and 261–348.

[1] Den svensk-norska expeditionen till Nordostlandet och farvattnen däromkring sommaren 1931, *Ymer*, Vol. 52, 1932, pp. 1–31.

Temperature, Radiation and Wind, by Anders Ångström; IX. Snow and Ice Temperatures, by Jonas Ekman Fjeldstad; X. Present Glaciation round the Norwegian Sea, by Hans W:son Ahlmann.

Two of the authors, Ångström and Fjeldstad, were not members of the expedition. Parts of the "Scientific Results" to be published later will deal with Geology, Oceanography, Plant Geography, and Quaternary Geology and Soil Polygons.

The bulk of the contents of the first ten parts is concerned, broadly speaking, with glaciology. Cartographic matter not thus specifically related includes:

1. A revised map of Northeast Land and adjacent islands, scale 1 : 750,000, with generalized isohypses. The expedition contributed to this map the astronomic locations of seven points, all but one on the smaller islands, detailed mapping of several localities, and the material for representing the relief of the inland ice. The outline of the north coast of Northeast Land is drawn from information supplied by Jens Olsen, a Norwegian skipper of long experience in the waters about Svalbard, and by Rolf S. Tandberg, who visited the region by sledge in connection with one of the relief expeditions occasioned by the wreck of the *Italia* in 1928.

2. A bathymetric chart of Barents Sea and the waters from north of Svalbard eastward to Franz Josef Land, incorporating soundings made by the *Quest* and by the *Nautilus* in 1931.

The expedition's meteorologic observations, made not only at the base station but also by the mobile parties, are worked into the discussions of glaciological problems, wholly in accordance with the view expressed by Alfred Wegener when planning his last Greenland expedition: "In the systematic investigation of continental glaciers, glaciologic and meteorologic research must always go hand in hand, since the problems of the two fields are intimately joined—precipitation with alimentation of the glaciers, interior temperature of ice and firn with air temperatures."

It is in the kind of investigation here urged by Wegener—the articulation of glaciological and meteorologic data—that the greater triumphs of the first ten parts of these "Scientific Results" lie. First rank is to be awarded without question to Anders Ångström's brilliant, though mathematically simple, evaluation of the meteorologic record in order to determine the relative roles of radiation and "convection" (transfer of heat from air to snow surface through atmospheric turbulence) in ablation. Depletion of the snow field at Sveanor was recorded in enough detail to permit the expression of ablation in millimeters of water an hour during the greater part of the field season. The measurements were made immediately adjacent to the meteorologic base station, so that the record of the significant meteorologic elements—insolation, air temperature, and wind velocity—could be used at once in interpreting rate of ablation. By a completely satisfactory numerical procedure Ångström shows that "radiation and convection contribute 37 and 63 per cent respectively of the observed ablation." No notable effect on rate of ablation was exercised by either precipitation or fog.

Ahlmann later uses Ångström's formulation to compute the relative shares of radiation and "convection" (*sit venia verbo!*) in the ablation of glaciers elsewhere, on the basis, of course, of less complete primary observations than were available from Sveanor. For the Styggedal glacier in southwestern Norway (latitude 60° 25′) he finds that about 70 per cent of the ablation is due to convection, about 30 per cent to radiation. Concerning glaciers on the south slope of Monte Rosa (latitude 45° 55′), a more continental site in a lower latitude, he concludes that "radiation plays a much more important role than convection in ablation." It is impossible to overestimate the significance of the approach to the study of ablation developed by Ångström. It provides a means hitherto unavailable for sorting out quantitatively the relative influence of the factors contributing to the depletion of glaciers.

Almost as high praise may be given to Ahlmann's collation of data on the altitude of the firn line and glaciation limit around the Norwegian Sea and to his estimates of

the quantity of solid precipitation accumulated and melted at this limit. Information on the balance of alimentation and ablation of glaciers at this most critical boundary is not so immediately illuminating as the results of Ångström's analysis, but it serves as a guide to the elucidation of regional, particularly climatic, contrasts. Ahlmann's table (p. 343) and map (Pl. 10) deserve a more penetrating discussion than their author gives them. He contents himself with pointing out contrasts between areas of maritime and of continental climate and with summarizing the pertinent climatic factors under these heads. It is evident, however, from examination of his map that any expression of the altitude of the firn line around the Norwegian Sea as a function of climate is not complete even with a measure of continentality that takes account of latitude. Some further recognition must be given to the unique oceanic and atmospheric circulation between the Atlantic Ocean and the Arctic Sea: at a minimum, the temperature anomaly of the sea surface adjacent to the glaciated lands should be adduced.

Ahlmann contributes further a map of the areas of accumulation and ablation, separated by an intermediate zone reflecting the year-to-year fluctuation of degree of ablation, of the inland ice of Northeast Land. The mapping was done from observations of the stratigraphy of firn and ice in the walls of pits dug in the glacier surface during the sledge journey of the glaciological party.

It is the temperatures observed in the walls of these pits at successive depths that are worked up by J. E. Fjeldstad. Fjeldstad brings to his discussion a mathematical procedure modeled after the one he devised earlier for defining the vertical transfer of heat in the water of the sea. His results are not wholly satisfactory, but his method shows how fuller observations should be handled when they become available. Under the assumptions made in order to solve his equations Fjeldstad finds that where the glaciers of Northeast Land have a thickness of not more than 270 meters their mean annual temperature throughout is below freezing. This conclusion depends mainly on the assumption that the movement of the glaciers and hence the frictional heat developed by movement are negligible.

Independently of Fjeldstad's theory of the flow of heat in firn and ice, Ahlmann presents a "geophysical classification of glaciers" in general terms of their temperatures. Since glaciological investigation will in all probability soon yield a classification of glaciers more fundamental than the current morphographic ones, Ahlmann's definitions are of more than passing interest:

"I. *Temperate glaciers* consist of crystalline ice formed by rapid recrystallization of the annual surplus of solid precipitation; in the summer the accumulation area is covered by a fairly thin layer of snow and firn. In the whole of the glacier the temperature corresponds to the melting point of the ice, except in the winter time, when the top layer is frozen to a depth of not more than a couple of metres. Such glaciers are probably situated in districts where the summer temperature is positive. This group includes the glaciers of Scandinavia and the Alps.

"II. *Arctic glaciers* consist, at least in their higher and upper parts, of hard crystalline firn formed by the slow recrystallization of the annual surplus of accumulated solid precipitation. The temperature of the glacier, at least in the accumulation area, is negative even in summer down to a depth of at least 100 m. or more.—These Arctic glaciers can be subdivided in:

"A. *High-Arctic glaciers* consist, at least in their accumulation areas, of crystalline firn to a depth of a couple of hundred metres or more. Even in summer, the temperature in the accumulation area is so low that as a rule there is no melting accompanied by formation of water. Such glaciers are probably situated in districts where the mean summer temperature is below about −10°. This group includes the Antarctic glaciers and most of the Greenland inland ice.

"B. *Sub-Arctic glaciers* consist in their accumulation areas of crystalline firn down to a depth of some ten or twenty metres. In the summer the temperature

allows melting accompanied by the formation of water. These glaciers are probably situated in districts where the mean summer temperature is 0° or slightly below. This group includes the North-East Land glacier-caps and probably most of the Spitsbergen glaciers."

To these he adds a further, "dynamic" distinction, between "active" and "inactive" glaciers:

"Active glaciers are characterized by an annual surplus, more or less considerable, of solid precipitation in their accumulation areas, the transport of material in them between the parts above and below the firn line is considerable, and the movement of the glacier is accordingly great.

"Inactive glaciers are characterized by an insignificant annual surplus of solid precipitation in their accumulation areas, the transport of material in them between the parts above and below the firn line is slight, and the movement of the glacier is accordingly small."

Glaciology is clearly about to undergo under the quickening touch of physical theory the transformation that is already far advanced in meteorology and oceanography. Ahlmann's categories do not quite meet the requirements of a rigorous physical science; his rough sequences will doubtless be replaced by continuous quantitative scales, to the larger divisions of which numerical limits more sharply defined than his will be assigned. But when glaciology has undergone its metamorphosis it will render to the "Scientific Results" of the Swedish-Norwegian Arctic Expedition of 1931 the honor due a distinguished precursor.

SOME BROADER ASPECTS OF THE HISTORY OF EXPLORATION

A REVIEW

J. K. Wright

THE central theme of the history of exploration is the record of routes traversed in the opening to knowledge of unknown regions. To this theme much must be added if the story is to acquire any real meaning. Large movements—colonial and commercial rivalries, missionary enterprises, advances in science, etc.—usually give the initial impulse to exploratory endeavors. Technical factors, themselves the result of generations of historical development, must also be considered—the design and construction of ships, firearms, and instruments; the truthfulness of maps; the arts of navigation and of overland travel; the ability to combat disease. Personal qualities, such as leadership, character, and knowledge of the psychology of native peoples, likewise play a critical part. Every exploring party encounters geographical conditions and forces in the regions through which it strives to advance and is carried forward by them or deflected or turned back. The contact of explorer with environment yields the adventures and the sufferings that have given exploration its absorbing interest since the time of Homer. Most writers on the subject have confined their attention to the adventures; few have attempted to analyze or to explain at all adequately the geographical circumstances from which these adventures arose.[1] Finally, it must always be remembered that explorations are links in a long chain of historical events. Each journey leads to further discoveries and to the acquisition of information that may profoundly influence the spread of population and the development of trade, industry, and science, and even of literature and the arts.[2]

Obviously no writer who aims to deal with the whole field of exploration "from the earliest times to the present day" in a single volume can possibly go into all of these broader aspects of the subject. He must leave out a great deal, and what he ordinarily omits is nearly everything but the central theme of routes followed and adventures experienced. Even so, he must choose, from the multitude of explorations about which it would be possible to write, a limited number of those that seem most important or interesting. If he aims at comprehensive treatment, he will give a little information concerning each of a great many expeditions, as was done by Baker[3] and by Plischke.[4] Plischke, to be sure, announces that his purpose is more than a mere enumeration and brief characterization of the most important events and undertakings in the history of exploration. These he aims to correlate with political, economic, and religious history, but this is a large task for some 160 pages and is done only in the barest outline. The book, however, is useful as an introduction and for the attention directed to the work of certain German and other non-British explorers in modern times.

If the writer's aim is to provide not a work of reference primarily but one that will appeal to the popular reader, he will select fewer expeditions in order that the significant achievements and dramatic episodes of each may be given more ample

[1] A notable exception is E. W. Gilbert's "The Exploration of Western America, 1800–1850: An Historical Geography," Cambridge and New York, 1933 (reviewed in the *Geographical Review*, Vol. 24, 1934, pp. 158–159).

[2] See *Geogr. Rev.*, Vol. 16, 1926, pp. 671–672.

[3] J. N. L. Baker: A History of Geographical Discovery and Exploration, London, 1931; see *Geogr. Rev.*, Vol. 22, 1932, p. 339.

[4] Hans Plischke: Entdeckungsgeschichte vom Altertum bis zur Neuzeit (Wissenschaft und Bildung, 290), Quelle & Meyer, Leipzig, 1933.

treatment. This is the purpose of Sir Percy Sykes in his pleasantly written volume[5] full of quotations from the writings of the explorers themselves, and of Leonard Outhwaite in "Unrolling the Map."[6] For the modern period Sykes deals largely but not exclusively with British explorers. About a tenth of the text is a record of explorations, mostly British, in Arabia since the eighteenth century; Plischke devotes about one three-hundredth of his text to this subject. "Earth Conquerors"[7] is not strictly a history of exploration, since the selection is reduced to nine explorers whom the author deems the greatest of all times: Leif Ericsson, Marco Polo, Columbus, Cabeza de Vaca, Magellan, Bering, Mungo Park, Richard Burton, and Nansen. For each of these a highly colored biographical sketch is given in a style that at times verges on the sensational.

A noteworthy feature of Outhwaite's book is a comprehensive series of maps. Except for the maps of the Polar Regions these are all drawn on Mercator's projection. Each map represents the status of knowledge attained at a given date. Unknown areas are indicated in black, known areas in white, and explorers' routes through the unknown by white bands. On some of the maps areas that had been explored before the date of the map but knowledge of which had subsequently been forgotten are distinguished by shading. Most of Outhwaite's text is devoted to the adventures and experiences of the outstanding explorers. Brief paragraphs on some of the lesser figures are also included, and short digressions in the form of notes on related topics, such as the development of navigation, the legend of Prester John, the introduction of the horse into America, mountain explorers, etc. The book is not altogether free from minor inaccuracies.[8]

Where the field is yet more definitely restricted in time and space, as in the remaining volumes under review, a larger opportunity is offered the writer to go behind the scenes and to probe more penetratingly into questions of cause and effect. "The Pioneer Histories" are "intended to provide broad surveys of the great migrations of European peoples—for purposes of trade, conquest and settlement—into the non-European" parts of the world. Several of the volumes are devoted to the history of the explorations that paved the way for these migrations. Beaglehole's "The Exploration of the Pacific"[9] covers the period from Magellan to Cook and tells the story of the discovery of the waters and islands rather than of the continental coast lines of the Pacific. The account centers around the search for Terra Australis Incognita, the imaginary Southern Continent that figured in learned treatises and on maps from the time of the Greeks until as late as the mid-eighteenth century. A striking introductory chapter entitled "The Problem Stated" gives a background for the whole book and points to some of the technical and psychological elements to which reference was made in the first paragraph of this review. Brebner[10] has attempted "to draw together as a related whole the explorations which first revealed the general character of the North American continent." "Hitherto," he states, "the subject has usually been treated regionally or nationally, with some loss of intelligibility as a consequence." Foster[11] narrates the early ventures of the British in the Orient, "not as a jumble of disconnected experiments, but as a

[5] Sir Percy Sykes: A History of Exploration from the Earliest Times to the Present Day. The Macmillan Co., New York, 1934.

[6] Unrolling the Map: The Story of Exploration. Reynal & Hitchcock, New York, 1935.

[7] J. Leslie Mitchell: Earth Conquerors: The Lives and Achievements of the Great Explorers. Simon & Schuster, New York, 1934.

[8] See more extended review by the present reviewer in the *New York Times*, Sunday Book Review, Feb. 24, 1935, pp. 1 and 14.

[9] J. C. Beaglehole: The Exploration of the Pacific (The Pioneer Histories). A. & C. Black, London; The Macmillan Co., New York, 1934.

[10] J. B. Brebner: The Explorers of North America, 1492–1806 (The Pioneer Histories). London and New York, 1933.

[11] Sir William Foster: England's Quest of Eastern Trade (The Pioneer Histories). London, 1933; New York, 1934.

drama of sustained effort, extending over more than a century" (ca. 1550–1700). The account of pioneer journeys into Russia, southwestern Asia, and India—lands almost unknown to Englishmen at the beginning of the period—merges into a history of commercial enterprises and conflicts.

Jeannette Mirsky in "To the North!"[12] gives a well balanced, vigorous, and colorful story of Arctic exploration. She quotes extensively from the original narratives and devotes adequate attention not only to the classic voyages in the Western Hemisphere but to the less familiar but no less important work of the Russians in Siberia and the ocean to the north. In the Introduction Stefansson expresses admiration for the author on the ground that "she has been trying to write a history not for the aggrandizement of a nation or the ennobling of youth but rather to get at and state facts." These facts, it may be added, include at least some of those larger circumstances without which no chronicle of exploration can give full satisfaction to readers whose tastes are genuinely historical or geographical.

Crouse[13] deals primarily with the expeditions of Parry, Ross, Franklin, McClure, and Amundsen. The volume supplements narratives of the earlier phase of the search for the Northwest Passage in the same author's "In Quest of the Western Ocean."[14] As the book is intended for popular consumption and for youthful readers, most of the space is given to simple, straightforward accounts of journeys. Neither in this volume nor in "To the North!" do the authors, in describing the fate of Franklin, mention the finding in 1930 by Major L. T. Burwash of camp sites, graves, and other relics of the Franklin expedition on the west coast of King William Island.[15]

H. R. Wagner's studies of early explorations along the west coast of North America have been noted or reviewed from time to time in this journal.[16] In contrast with the other works under discussion, which deal synthetically with fairly well known explorations, the main purpose of Wagner's studies has been to provide scholars with texts and translations of documents bearing on relatively obscure voyages and with reproductions of pertinent early maps. The expeditions of Quimper in 1790, of Eliza in 1791, and of Galiano and Valdés in 1792 form the main theme of "Spanish Explorations in the Strait of Juan de Fuca."[17] Wagner points out that "Vancouver was not the first to explore these channels [i.e. the Strait of Juan de Fuca and connecting waterways], to anchor in these ports and to view the majestic mountains, even although many of these still bear the names he gave them." "My aim is to do justice to the Spaniards who preceded him and who have left us accounts of their experiences just as vivid and entertaining as his."

The maps in the volumes under review, with the possible exception of Wagner's and Outhwaite's, leave a good deal to be desired. This is partly due to considerations of cost, for which the authors cannot be held wholly responsible; but, even so, the history of exploration demands far more ingenious cartographic expression than has hitherto been given it. The conventional outline map showing routes on bases depicting shore lines, rivers, and occasionally mountains, as now known, is useful as far as it goes, but it fails to give a graphic conception of the progress of discovery. Ideally it should be supplemented by maps like Outhwaite's and Plischke's showing the status of knowledge at successive dates. Outhwaite's maps are a step in the right direction, but the use on most of them of Mercator's projection, with its exaggeration

[12] To the North! The Story of Arctic Exploration from Earliest Times to the Present. The Viking Press, New York, 1934.

[13] Nellis M. Crouse: The Search for the Northwest Passage. Columbia University Press, New York, 1934.

[14] William Morrow & Co., New York, 1928.

[15] See L. T. Burwash: Canada's Western Arctic: Report on Investigations in 1925–26, 1928–29, and 1930, Dept. of the Interior, North West Territories and Yukon Branch, Ottawa, 1931, pp. 83–98.

[16] *Geogr. Rev.*, Vol. 18, 1928, pp. 340–341; Vol. 19, 1929, pp. 174–176; Vol. 20, 1930, pp. 694–695; Vol. 22, 1932, pp. 488–489.

[17] Fine Arts Press, Santa Ana, Cal., 1933.

and distortion of high latitudes, is to be regretted, and more refinement of detail might have been put into the preparation of some of them. Maps of this sort, moreover, are not wholly sufficient if the known and the unknown are invariably drawn as they appear on modern maps. What explorers have expected to find or have believed they have found is often fully as important historically as where they have actually been. Reproductions of early maps, or of simplified tracings taken from them, might well be regarded as essentials. It is a pity, for example, that one or more maps showing theories of Terra Australis Incognita do not appear in Beaglehole's excellent book. It may also be pointed out that the coast lines laid down on the general maps of the Arctic in the works of Mirsky and of Crouse are out of date in several particulars—notably in the fiord region of East Greenland in the former, the western shore of M'Clintock Channel in the latter, and parts of the western and northwestern coasts of Baffin Island in both. These shores have for some years been correctly depicted on published maps that are readily available.[18]

[18] See the "Physical Map of the Arctic," 1 : 20,000,000 (and inset, "Eastern Greenland," 1 : 5,000,000), accompanying W. L. G. Joerg: Brief History of Polar Exploration Since the Introduction of Flying, *Amer. Geogr. Soc. Special Publ. No. 11*, 1930; and "Map of the Northwest Territories," scale 60 miles to 1 inch (1 : 3,801,600), Dept. of the Interior, Canada, Natural Resources Intelligence Service, 1929.

THIRTY-FIRST ANNUAL MEETING OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS

THE Association of American Geographers met at Philadelphia on December 27, 28, and 29, 1934, for its thirty-first annual meeting. The sessions were held in Houston Hall of the University of Pennsylvania, with Dr. Wallace W. Atwood, President of Clark University and President of the Association for 1934, in the chair. The widespread participation in the discussions and the general spontaneity that characterized the meeting were the cause of favorable comment by many members. Discussion was facilitated by the improved grouping of papers according to topical or regional relationships. A map exhibit by members, publishers, and the local organizing committee was displayed. The section prepared by the local committee dealt with regional planning in the Philadelphia Tri-State District, i.e. the metropolitan area extending from Wilmington to Trenton. The Geographical Society of Philadelphia devoted the January, 1935, number of its *Bulletin* to an analysis of the site and situation of Philadelphia and distributed the issue with its compliments to those in attendance. Tea served to the members and their guests through the courtesy of the Society provided a social interruption in the afternoon sessions.

The following officers were elected for 1935: Charles C. Colby, president; C. H. Birdseye, vice-president; J. E. Orchard, treasurer; F. E. Williams, secretary; Kirk Bryan, councilor for three years. Other members of the Council during 1935 are W. W. Atwood, Ralph H. Brown, Preston E. James, and F. E. Matthes. Derwent Whittlesey is editor of the *Annals*.

About thirty-five papers, half of them by persons introduced by members, were read, exclusive of the President's address and invited papers in a discussion of regions.

Conference on the Regional Principle

The regional discussion had been organized by Ralph H. Brown, who was unfortunately unable to be present. Its theme, announced as "A Conference on Regions," was dealt with in four papers under three heads. Responses by one or two prepared speakers followed. The three topics were "Regions in Geography: A Résumé" by R. B. Hall (read by another member in Professor Hall's absence; responses by W. L. G. Joerg and Derwent Whittlesey); "Statistical Approach to Regions" by G. T. Renner and S. Van Valkenburg (response by J. W. Frey); and "Field Approach to Regions" by Robert S. Platt (responses by Roderick Peattie and Richard E. Dodge). The papers and discussions will be printed in full in a forthcoming issue of the Association's *Annals*.

Professor Hall, after pointing out the significance of the regional concept to various disciplines—to history it has furnished the doctrine of sectionalism, to anthropology the culture area, to sociology the total situation, to economics the economic domain, to biology the biotic area or region—emphasized the fact that to the geographer the ultimate goal of all regional study should be the creation of a sound, comparative world pattern of regions, i.e. systematic geography.

Dr. Renner's paper called attention to a number of regional subdivisions of the United States on the basis of statistical criteria, such as Elliott's type-of-farming map (see *Geogr. Rev.*, Vol. 24, 1934, pp. 325–326) and a recent map attempting to show land-use maladjustments. Van Valkenburg used Europe as an example. From criteria similar to those employed by Mark Jefferson in his "The Culture of the Nations" (*Bull. Amer. Geogr. Soc.*, Vol. 43, 1911, pp. 241–265), he arrived at a result that clearly defined the contrast between western and eastern Europe.

In the third part of the regional discussion Robert S. Platt presented a recon-

naissance cross section between the settled part of Canada at Toronto and Moosonee, the end of the new railroad to Hudson Bay, to illustrate the regional differentiation in such a traverse.

Other Regional Papers

Statistical methods of regional study were employed in an excellent joint study by Samuel Dicken (introduced) and Richard Hartshorne to delimit the agricultural regions of Europe and North America on a common basis, the results being presented in a paper of corresponding title which was read by Dr. Hartshorne. The geographic regions of Russia as developed from a consideration of the constituent elements were outlined on a map and in a paper by George D. Hubbard.

Two other papers dealt with regional groupings. "Population Regions of New England and Their Significance in the Analysis of the Cultural Landscape" by Stanley D. Dodge classified the area into units according to the character of their population growth. Under "Regionalism in Industry" Helen M. Strong discussed the concentration in the United States of industry and manufacturing in nuclear centers as well as in the northeastern part of the country.

Some aspect of regional geography or some question touching upon a region was discussed in a number of papers. A field study of a Finnish community in a submarginal district of northeastern Minnesota was presented by Darrell H. Davis (to be published in the *Geographical Review*). In an excellent "chalk talk," in which the map progressively developed under his crayon, Derwent Whittlesey traced the growth of Old Boston from its foundation to the present. W. L. G. Joerg characterized as the outstanding contemporary map portrayer of the territory of the United States Henry S. Tanner of Philadelphia, whose "New American Atlas" (1823), with its state or state-group maps on the uniform scale of about 1 : 1,000,000, and whose map of the United States, 1 : 2,000,000 (1829), were based on a critical compilation of primary source material. C. E. Batschelet (introduced) described the new series of state base maps published by the Bureau of the Census showing minor civil divisions. Latin America was represented by two papers, one on the hydrography of the Valley of Mexico by F. A. Carlson (introduced) and the other on the intercommunity trade of the Indians of the Atitlán basin in Guatemala by Rollin S. Atwood (introduced). The Chinese scene was dealt with by G. B. Cressey, who described the canal and dike-fretted Fenghsien landscape 20 miles south of Shanghai in the Yangtze delta.

Land Use and Land Planning

A number of papers reflected the recent trend toward land-planning studies. S. P. Poole (introduced), in a survey of the various resources and functions involved in land use, presented the results of the recent report on New York State published by the State Planning Board. G. Donald Hudson (introduced) discussed the results obtained in an area in the upper Shenandoah Valley, of a novel method of land-use field reconnaissance by automobile. By pushing the appropriate buttons on the dashboard of the car, each of which stands for a specific type of land use, it is possible in traveling over the roads to make a rapid reconnaissance survey of the type of land use extending back from a given stretch of road as far as visibility allows. In a region where the road net is dense enough a fairly accurate continuous map of an entire area can be produced by interpolation. C. P. Barnes (introduced) suggested the adoption in areas of new settlement of the long-lot type of farm instead of the usual rectangular pattern of the public domain. His paper is published in this number of the *Geographical Review* (pp. 298–301). In a preliminary study R. M. Brown discussed "The Business of Recreation," drawing on the various "summer resort," forest-reserve, wild-life, and other similar areas to illustrate the general principles.

Population

The outstanding discussion of population was C. W. Thornthwaite's "Internal Migration in the United States" recently published by the University of Pennsylvania (see note in the record section of this number of the *Geographical Review*). F. A. Stilgenbauer (introduced) displayed a new population dot map of Detroit that he had compiled. Howard H. Martin (introduced) essayed a geographical, as contrasted with a statistical or economic, interpretation of the Japanese population curve.

Political and Economic Geography

Richard Hartshorne, under the title "The History, Nature, and Scope of Political Geography," supplied an excellent analysis of the development of concepts in this field. He came to the conclusion—a conclusion, it may be said, he had justified through his earlier paper on Upper Silesia (*Annals Assn. of Amer. Geogrs.*, Vol. 23, 1933, pp. 195–228)—that, in contrast with the concept of the subject in Ritter's time as being the geography of history and with the concept of the World War period as being applied geography, political geography in its modern development leads from the descriptive analysis of the problem or problem area, through interpretation, to an appraisal that can really be objective. The presidential address of President Atwood likewise dealt with a theme in political geography, "The Increasing Significance of Geographic Conditions in the Growth of Nation-States."

Economic geography was represented by four papers. The world's wheat surplus was discussed by Thomas R. Smith (introduced); this paper was published in the preceding number of the *Geographical Review* (pp. 107–116). The development of manufacturing in Hamilton, Ontario, was the subject of a paper by Harold B. Ward (introduced). The distribution of industries in the state of São Paulo, Brazil, and their growth from the old era of open workshops to the modern one of large industrial plants were outlined by Preston E. James. A detail in the economic geography of Ireland was described by L. E. Klimm (introduced) under the title "The Rain Tanks of the Aran Islands: A New Adjustment to Karst Conditions."

Climatology

"Pure" and applied climatology formed the theme of five papers. E. E. Lackey (introduced) presented and commented on a variability series of frost maps of Nebraska, on which the isopleths expressed the percentage of occurrence of killing frost on a given date, on the basis of the record from 1897 to 1933. J. K. Rose (introduced) discussed an interesting procedure whereby the boundaries of the Corn Belt and its subdivisions were determined on the basis of correlation of the corn yield with critical climatic factors, such as July rainfall or accumulated temperature above 90° F. for June. Charles F. Brooks described the thirty climatic maps of North America that have been prepared for this section of the Köppen-Geiger "Handbuch der Klimatologie." R. G. Stone (introduced) discussed some possibilities and limitations of the newly developed air-mass method of analysis in dynamic climatology. Ellsworth Huntington, under the title "Caravan Cities, Climate, and History," discussed apparent evidences of climatic change in Palestine and Syria. A line drawn on the map of these regions separating present-day ruins from the dwellings occupied today coincides closely with the boundary between the arid and humid areas of our time; yet the ruins attest livable conditions in the heyday of the abodes of which they are the remnants. The present lack of parallelism between ancient dune axes and present direction of prevailing winds points to a change. The increase of east winds since the first century has probably spelled greater desiccation. As the climate grew drier the caravans, instead of going east from Petra, went north as far as Palmyra, thence to cross the Syrian Desert eastward.

Physiography

Physiography was represented by papers on the erosional history of the Wind River Range, Wyoming (by Wallace W. Atwood, Jr., introduced), on the history of the Rio Grande in central New Mexico (by Kirk Bryan), and on the coastal marshes of southwestern Louisiana (by R. J. Russell). The last-named paper (to be published in the *Geographical Review*) pointed out that submergence is taking place on both sides of the lower Mississippi River, as indicated by boreholes made in Indian mounds which show that their base is about 6 feet below the present surface. In contrast with the sinking of the coast is the advance of the Mississippi delta, which is the most active geosyncline in North America today, with sedimentary materials extending downwards 25,000 feet, or twice the maximum depth of the Gulf of Mexico. Physiographic maps of the Sahara and adjacent regions were displayed by Erwin Raisz (introduced). Executed in the block-diagram style of other maps by the same author, the Sahara map, on the basis of Gautier's work, differentiated *hamada* or flat-topped plateau, *erg* or elongated sand belt, *reg* or gravel desert, and mountains. A warm tribute was paid by Kirk Bryan to the memory of Professor W. M. Davis, founder of the Association of American Geographers and "leader in geomorphology and geography," who died on February 5, 1934 (see the *Geogr. Rev.*, Vol. 24, 1934, pp. 177–181).

Other Papers

J. Russell Smith answered his own question "Are We Free to Coin New Terms?" in the affirmative but urged that the terminology in a subject of general interest such as geography should be generally understandable.

The twenty-fifth anniversary year of the North Polar journey afforded W. H. Hobbs an appropriate opportunity for reviewing Peary's polar explorations. The significance of the International Geographical Congress at Warsaw, 1934, was explained by John K. Wright (see the report on the Congress in the *Geogr. Rev.*, Vol. 25, 1935, pp. 142–148).

AMERICAN GEOGRAPHICAL SOCIETY

The December Meeting. The regular monthly meeting of the American Geographical Society was held on December 20, 1934, at the Engineering Societies' Building, 29 West 39th Street, Mr. Oliver B. James in the chair. Dr. Carl Skottsberg delivered a lecture on "The Tip of the Andes: Exploration in the Cordillera of Patagonia and Tierra del Fuego." Dr. Skottsberg, who is Professor of Botany at Upsala University and Director of the Botanical Gardens at Göteborg, has conducted a number of expeditions in Patagonia and Tierra del Fuego. His lecture dealt with the results of his various journeys and was illustrated with lantern slides.

The January Meeting. The Annual Meeting of the Society was held on January 24, 1935, at the Engineering Societies' Building, 29 West 39th Street, President Redmond presiding. A summary of the Annual Report of the Chairman of the Council (printed below) was read by the President. Mr. Redmond then submitted the report of the Special Committee to nominate officers for 1935. Dr. John H. Finley, who announced his retirement as President of the Society at its Annual Meeting on January 26, 1934, was elected Honorary President of the Society. After the election of officers Dr. George B. Cressey delivered a lecture on "The Chinese Landscape." Dr. Cressey, who is Chairman of the Department of Geology and Geography at Syracuse University, has spent a number of years as Professor of Geology at Shanghai University and has conducted a number of expeditions in the interior of the country. He had just returned from a five-months' study of land utilization there. The lecture was excellently illustrated with lantern slides.

The February Meeting. The regular monthly meeting of the Society was held on February 26, 1935, at the Engineering Societies' Building, 29 West 39th Street, President Redmond presiding. Mr. Bertram Thomas delivered a lecture entitled "Native Life and Exploration in Arabia." In 1932 Mr. Thomas was awarded the Society's Cullum Geographical Medal for his journey in 1930–1931 across the Rub' al Khali, the "Empty Quarter" of Arabia, which up to that time constituted the largest expanse of wholly unexplored territory outside the Antarctic continent. His lecture dealt with the exploration of Arabia by Europeans and was illustrated with lantern slides showing the development of the map of Arabia and types of the natives in the various sections explored.

Announcement was made that Dr. Isaiah Bowman, the Director of the Society, had been elected President of the Johns Hopkins University to succeed Dr. Joseph S. Ames who retires on June 30 next. Dr. Bowman will have continuing interest in the Society and especially in its major research projects which have been developed and supported during the past fifteen years.

Election of Councilor. At the meeting of the Council of the Society held on January 17, Mr. Carl C. Shippee was elected Councilor of the class of 1938.

Elections of Fellows. At the December, January, and February meetings of the Council of the Society, the names of 84 candidates were presented who were duly elected as Fellows of the Society.

The "Bibliographie Géographique Internationale" for 1933. The forty-third issue of the *Bibliographie Géographique Internationale* is now ready for distribution in the United States by the American Geographical Society. It is published by the Association de Géographes Français with the collaboration of the American Geographical Society, the Comitato Geografico Nazionale Italiano, the Royal Geographical Society (London), the Société Belge d'Études Géographiques, and the Société Royale de Géographie d'Égypte. The material listed is critically selected,

and brief critical notes or references to reviews in outstanding geographical periodicals are added to many of the titles. Current publications—books, periodicals, government and state publications, and maps—are included.

ANNUAL REPORT OF THE COUNCIL

January 17, 1935

To the Fellows of the Society:

The founders and early patrons of the Society can hardly have foreseen even in outline the many activities that the institution has since developed. Although the fundamental object—"the advancement of geographical science"—has been foremost since 1852 and is wisely stated in broad terms in the amended charter of 1871, especial emphasis is there laid on the collection of books, maps, and geographical information "to be at all times accessible for public uses in a great maritime and commercial city." This function of immediate service to the local community the Society has sought to fulfill from the beginning. Its library and map collection are open to the public, and those in charge of the collections hold it a primary duty to render expert assistance to all who may wish to consult them.

Although this direct service to the city has never been neglected, the Society in recent years has greatly broadened the scope of its interests. The details that follow on current work in different fields bear ample witness to this. Through original research carried on by members of its staff, through their active participation in large undertakings of other organizations, through the dynamic part that they have taken in both governmental and international enterprises, through a periodical and other publications that not only appeal to all who are geographically minded—professional geographers, teachers of geography, and laymen alike—but also set high scientific and technical standards, and through the critical recognition of genuine achievement in geography by awards and other forms of honor, the Society has gained a position of leadership and of influence in the "advancement of geographical science" and the applications of geographical science in the solution of problems of human welfare.

The Geographical Review

The publication of the *Geographical Review* as a quarterly permits the presentation of a balanced and harmonious table of contents in each number; principal articles, notes from the contemporary record, and reviews are brought together for the light they shed upon one another, while a variety is maintained that, in the course of the year, is representative of the entire geographical domain. The number for October last, for instance, gives a new interpretation of "Magellan's Route in the Pacific" and "An Early Account of Bering's Voyages," newly rendered into English, as well as a new conception of a corollary to the great voyages in a paper on "Drift Iron," a form of iron in which the Iron Age was introduced into many corners of savagedom. A still earlier stage of Iron Age civilization is the theme of "The Early Casting of Iron," while the latest phase of a problem dependent on coal and iron appears in the article on "The Geographic Background of the Saar Problem." Primarily interesting as studies in land utilization are an account of one of the most remarkable achievements in Italy's program of *bonifica integrale*, "The Reclamation of the Pontine Marshes"; a study of Zagazig, an ancient site in the Nile delta, risen to importance in the modern world by its exceptional opportunities for cotton cultivation and marketing; a study of irrigation in a dry-farming area of Montana, "a special problem because of the tendency, on the one hand, to overestimate irrigation as an agency of change and, on the other, to minimize the vitality of a well established dry-land culture"; and the "Land Utilization Survey of Britain." Three

problems in physical geography are discussed from new angles, and the question "Is the Population of the United States Now Decreasing?" is propounded.

In the July number of the *Review* a group of four papers deals with Japan and the Japanese Empire—with a basic physiographic map (1 : 4,000,000), settlement in Hokkaido, the distribution and growth of Japan's cities, and land-utilization maps of Korea. A paper on commercial grain farming in the Columbia Plateau is followed by an analysis of the peculiar soil-erosion problem in the heart of this famous wheat country.

Other articles in the volume for 1934 treat of population and related topics: the possibilities of white settlement in the tropics ("White Settlement in Saba Island, Dutch West Indies"); the problems that arise from rubber and tin exploitation ("The Population of the Malay Peninsula: A Study in Human Migration"); the distribution of population in the Lake St. John Lowland, Quebec; population trends in northwestern New England; and the metropolitan regions of the United States. The last opens up a number of lines of investigation in the field of urban geography. The best usage of our natural resources is discussed in "Peat-Land Utilization" and "A National Plan for American Forestry." Studies of regions whose political history has made for complications in their development embrace: "The Upper Silesian Industrial District," dealing with a border area presenting certain resemblances to the Saar; "Land Problems in Puerto Rico and the Philippine Islands"; and "The Murray River Basin," a natural unit divided by "states rights."

Among papers on exploration are the "Physiographic Results of a Recent Survey in Little Tibet," with a map (in color) on the scale of 1 inch to 8 miles, the work of the Yale North India Expedition of 1932; and a narrative with map and panoramas of the first ascent of Minya Konka, the second highest summit ever attained. Accounts are also given of a reported Eskimo discovery of an island off northern Alaska, of the work of the Michigan–Pan American Airways Greenland Expedition of 1932–1933 on the west coast of Greenland, of the excavation of the monument of Tin Hinan in the Ahaggar, heart of the Sahara, and of explorations in East Greenland and in the Sierra Nevada de Santa Marta of Colombia. The story of recent exploration in Patagonia is summed up in a review of current literature in that field, and there is a report on the discovery of a new sketch of Cape Hudson, Antarctica, throwing further light on Wilkes's journey.

"The Inter-American Highway Reconnaissance in Central America" is largely a description of the method of aerial surveying used in an undertaking of international importance. "The Museum of Regional Geography in Leipzig" describes one of the world's two strictly geographical museums (an account of the other, the Leningrad Museum, appeared in the 1929 volume of the *Review*); a device helpful to graphic understanding is explained in "The Rectangular Statistical Cartogram." "Climatic Years," developing an important concept in the study of the human aspects of climatology; an investigation of the altitude of tree and pasture lines in Europe; a new view of the débris-transportation characteristics of streams; a question on the accepted origins of submarine canyons—these are all contributions in the physical field. The question last mentioned is raised in a posthumous paper by Professor W. M. Davis, to whose trenchantly wielded pen we also owe the opening article of the year on "The Long Beach Earthquake," a challenge to human foresight to meet the peculiar problems of a seismic environment. Tributes to Professor Davis and to the late Mr. John Greenough, Honorary President of the Society, conclude the list of the principal contents in the volume of the *Geographical Review* for 1934.

Special Publication

During the year editorial work was completed on "The Fiord Region of East Greenland," by Louise A. Boyd and others. This volume, with an accompanying

slip case of illustrative material, was published early in January, 1935, and deals primarily with Miss Boyd's East Greenland expedition of 1933, concerning which a briefer report was contributed by Miss Boyd to the *Geographical Review* for July, 1934. The publication includes more than 360 photographs and panoramas of fiords, glaciers, glacial-marginal features, mountains, icebergs, pack ice, etc. Nearly all of these views were taken by Miss Boyd herself. Many are of exceptional beauty, and the collection as a whole forms a pictorial record of polar landscapes both unique and of notable scientific value. In the text Miss Boyd contributes a narrative of the expedition of 1933 with incidental remarks on her visit to the same region in 1931; Professor J Harlen Bretz of the University of Chicago discusses the physiographic studies of the expedition and gives an interpretation of the origin of the fiords; O. M. Miller, head of the Society's Department of Technical Training, and W. A. Wood, now of the Society's staff, give an account of photogrammetrical surveys made and methods employed; Dr. W. B. Drew of the Gray Herbarium, Harvard University, lists and comments on the botanical collections of 1931 and 1933. In addition to these contributions by members of the party, the volume contains an analysis by C. B. Hitchcock, now of the Society's staff, of the echo soundings taken in the fiords and on the voyages across the Greenland Sea from Norway to Greenland and return. The concluding article is a historical outline of earlier explorations in the region, by Dr. John K. Wright, Librarian of the Society.

The slip case contains, besides panoramas, echo-sounding profiles, and a bathymetric map of part of the Greenland Sea, the cartographic results of the photogrammetrical surveys that constituted one of the main objectives of the expedition. These consist of three colored plates on which appear a contour map of the hitherto unexplored Gregory Valley in Fraenkel Land (1 : 50,000), detailed maps of three glaciers reproduced on the large scale of 1 : 5000, a general map of the vicinity of the head of Franz Josef Fiord (1 : 500,000), and two minor maps, all compiled and drafted at the Society.

Department of Hispanic American Research

Six new sheets of the Millionth Map of Hispanic America were published in 1934, bringing the total of published sheets to 50. The compilation work is nearly completed on the remaining 52 sheets, and it is expected that the fairdrawing will be completed by the end of 1935.

Department of Technical Training

Instruction in various methods of surveying was given to six persons during the year. As usual, many others consulted the staff of the department for information and advice, and surveying instruments were lent to six field parties.

The work of the department was largely devoted to the preparation of the topographical map of 5000 square miles in northern Labrador that is being constructed from oblique photographs taken by the Grenfell-Forbes Expedition of 1931. The preliminary work of determining and plotting the network of control points fixed from the air is nearly completed, and good progress has been made on the plotting of the topography. The method used is one developed at the Society for mapping from oblique aerial photographs. The method has been greatly improved and simplified as a result of the experience gained in constructing the map. New formulas have been developed whereby the whole process of fixing the position of the air stations and obtaining the tilt and direction of the camera axis at the moment of exposure can now be completed in two approximations. The accuracy of the work has far exceeded expectations, and it has been found possible to plot large sections of the area on a scale of 1 : 50,000 instead of 1 : 100,000 as originally planned.

Library

During the year 513 books, 503 pamphlets, 998 volumes of periodicals, 2295 maps, and 29 atlases were added to the Society's collections. The collections now consist of 100,425 books and volumes of periodicals, 17,156 pamphlets, 89,341 maps, 1718 atlases, and 9190 photographs.

Among the gifts to the library and map collections in 1934 are: Carvajal's "Descubrimiento del rio de las Amazonas," 1894, from Professor H. C. Heaton; Love's "Geodaesia," 1796, "Instructions to Surveyors General" (U. S. General Land Office), 1855, Beckford's "Italy," 1834, Galton's "Vacation Tourists," 1864, and Macleod's "Eastward," 1866, from Abbot Low Moffat, Esq.; five volumes of *Proceedings*, from the Geologists' Association, London; Häolé's "Sandwich Island Notes," 1854, from Mr. A. B. Hoen; Danet's "A Complete Dictionary of the Greek and Roman Antiquities," 1700, from Mr. G. A. Skrzyneki; four volumes of "Spedizione italiana de Filippi nell' Himàlaia, Caracorùm e Turchestàn Cinese," from N. Zanichelli; more than fifty volumes, mainly Peruvian or dealing with Peru, from Mrs. R. V. Bingham; manuscript chart, apparently of a section of the South Shetland Islands, from Mrs. Sidney Bradford; "Monumenta Cartographica Bohemiae," from the Charles University, Prague; facsimile of a Catalan world map of ca. 1450, from the Royal Geographical Society, London; 30 sheets of the topographic map of Minas Geraes, from the Departmento dos Servicos Geografico e Geologico, Minas Geraes; map of Muscle Shoals area in ten sheets, from the U. S. Engineer Office, Nashville; 281 sheets of topographic survey, from the Mississippi River Commission; "Monumenta cartographica Africae et Aegypti," Vol. III, Part 3, from Prince Youssouf Kamal; maps of France, five sheets, from Mr. L. E. de Forest; "Commercial Atlas of America," 1934, from Rand McNally and Company; section of "Carte géologique du Congo belge," from Ministère des Colonies, Belgium; "Atlas de France," 4 *livraisons*, from Comité National de Géographie; two sheets of the South African topographic survey, from the Trigonometrical Survey Office of the Union of South Africa; "Ethnographic Map of Siberia," from the Russian Academy of Sciences; "Map of Distribution of the People of the Far North," from the Northern Tribes Assistance Committee of the All Russian Executive Committee; set of maps including an aerial survey of Gaspé, from the Department of Lands and Forests, Quebec; 90 sheets of map of the Argentine (1 : 500,000), from Instituto Geográfico Militar; collection of maps of France and the African colonies, from Service Géographique de l'Armée; 86 topographic sheets from the Survey of India; 117 topographic sheets from the Survey of Egypt; "Atlas des colonies françaises," from the Société d'Éditions Géographiques, Maritimes et Coloniales; Brüning's "Atlas Niedersachsen," from Gerhard Stalling; 17 charts of the coast of Libya, from the Istituto Idrografico della R. Marina; six volumes of aerial mosaics of the Inter-American Highway Reconnaissance Surveys, from the U. S. Bureau of Public Roads; more than 350 photographs from Miss Louise A. Boyd; and 80 photographs from Dr. Isaiah Bowman.

Cards representing more than 6000 titles of books, periodical articles, and maps were added to the research catalogue, which now contains some 68,500 entries.

The library continued its coöperation with the Association de Géographes Français and other geographical institutions in the preparation of titles and abstracts for the *Bibliographie Géographique Internationale*.

Since 1911 the Society has distributed the *Geographical Review* free of charge to all members of the Association of American Geographers and has continued this policy during the past year despite great difficulties in finding funds to continue its own immediate activities. It has done so because of the wide use that is made of the materials in the *Review*, including its maps and illustrations, in classroom instruction in the universities and colleges. The subject matter of the *Review* is thus brought into active relationship with advanced education in geography and ulti-

mately reaches many thousands of students. For much the same reason the *Review* is distributed at a reduced price to all school teachers who are not members of the Association of American Geographers.

Dr. John K. Wright, Librarian of the Society, was granted leave of absence during the summer and early autumn to attend the International Geographical Congress at Warsaw and for study of geographical collections in European museums. For the latter purpose he visited museums in Great Britain, France, Germany, Poland, Austria, and Switzerland.

Coöperation in Other Enterprises

The Society was officially represented at the Fourteenth International Geographical Congress at Warsaw, August 23–31, by the Director (Dr. Bowman), the Librarian (Dr. Wright), and by Miss Louise A. Boyd of San Francisco. Dr. Bowman, as retiring President of the International Geographical Union, served as President of the Congress; Dr. Wright served as one of two Vice-Presidents of the historical section; and Miss Boyd presided at one of the special sessions.

Members of the staff of the Society attended the annual meeting of the Association of American Geographers at Philadelphia, December 27–29, and will report on the meeting in the *Geographical Review*.

Since July 1, 1933, Dr. Bowman, the Director of the Society, has served as Chairman of the National Research Council and since August, 1933, as Vice-Chairman and Director of the Science Advisory Board appointed by President Roosevelt on July 30, 1933. His services to these two organizations are indicated in their respective annual reports, the latter printed in book form. He has given special attention to the work of a land-use committee of the Science Advisory Board, of which he is chairman, and to committees on the topographic services in the government and on the Weather Bureau, and to Congressional support for the International Scientific Unions. Mention should also be made of his membership on a Commission of Inquiry into National Policy in International Economic Relations, which was appointed by the Social Science Research Council and which rendered a report to the American public in November, 1934.

In the prosecution of its work on land use the Science Advisory Board engaged the services of Mr. W. L. G. Joerg, Editor of the Society's Research Series, for coöperation with Professor Carl O. Sauer in the preparation, by the latter, of a comprehensive report for the Science Advisory Board entitled "Land Resource and Land Use in Relation to Public Policy." Mr. Joerg edited and annotated the report, conducted conversations with government officials, and assisted in the work of certain government groups engaged in the study of problems of land use. Mr. Joerg served also as a member of Professor Douglas W. Johnson's Committee of the Science Advisory Board on the Mapping Services of the Federal Government.

At the request of the Secretary of the Interior, the Society has appointed Mr. R. R. Platt, head of the Department of Hispanic American Research, to serve on the Advisory Board on Geographic Names recently established to take the place of the United States Geographic Board. This board, which for more than forty years has had final decision on the selection among existing names of places and physical features within the territory of the United States, the bestowal of new names, pronunciation, etc., was abolished by Executive Order on April 17, 1934, and its functions transferred to a Division of Geographic Names in the Department of the Interior within which the new Advisory Committee has been appointed. The new committee consists of representatives from the government bureaus concerned with map production and use, the American Geographical Society, the geographical societies of Philadelphia and Chicago, and the National Geographic Society.

A dinner in honor of the Arctic explorers Otto S. Schmidt and George A. Ushakov

of the U.S.S.R. was given on May 23 by the American Russian Institute for Cultural Relations with the Soviet Union, the Explorers Club, the American Museum of Natural History, and the American Geographical Society.

Lecture Program

During the past year the speakers and titles on the Society's lecture program were as follows: Dr. Anson Phelps Stokes, "Africa and Its Problems"; Dr. Peter H. Buck, "Polynesian Discoverers of the Pacific"; Dr. Frank R. Oastler, "The Lake Regions of the Canadian Rocky Mountains"; Miss Louise A. Boyd, "The Louise A. Boyd Expedition to East Greenland in 1933"; Mr. Robert E. Fulton, Jr., "South of the Hindu Kush"; Dr. Carl Skottsberg, "The Tip of the Andes: Exploration in the Cordillera of Patagonia and Tierra del Fuego."

Decease of President Greenough

The decease of our Honorary President, John Greenough, on May 4 brought to a close a period of usefulness to the Society that has been equaled by but few of our past officers. An account of his services, the positions that he filled, and the spirit that he brought to the Society's deliberations and activities was published in the *Geographical Review* for July, 1934. Suitable resolutions were passed by the Council at its next succeeding autumn meeting.

Report of the Treasurer

The Council has received a report from the Treasurer giving a summary of the income and expenses of the Society, and the accounts of the Society have been audited by certified accountants whose report is on file at the office of the Society.

Philip W. Henry, *Chairman*

REPORT OF THE SPECIAL COMMITTEE

New York, January 17, 1935

The committee appointed at the meeting of the Council held on December 13, 1934, to nominate officers for the vacancies to occur in the Council in January, 1935, beg to nominate the following named gentlemen for the offices designated and move that the same be approved and presented to the Society for election at its meeting to be held on January 24, 1935.

		Terms to expire in
Honorary President	John H. Finley	
President	Roland L. Redmond	January, 1936
Vice-President	Philip W. Henry	January, 1938
Vice-President	Oliver B. James	January, 1936
Domestic Corresponding Secretary	Paul Tuckerman	January, 1938
Treasurer	Henry Parish	January, 1936
Councilors	F. Trubee Davison John H. Finley William A. Rockefeller Carl C. Shippee	January, 1938

Philip A. Carroll
William Hale Harkness
Wesley C. Mitchell
} *Committee*

GEOGRAPHICAL RECORD

NORTH AMERICA

Our Potential Parents and Potential Population. The work of two recent writers —Frank Lorimer and Frederick Osborn, "Dynamics of Population" (1934)—contains a great variety of interesting matter. Two points only will be discussed here (for reviews see *Science*, Nov. 30, 1934, pp. 504–505, and *Nature*, Jan. 12, 1935, pp. 46–48). The authors note that the 1930 census shows "fewer children" "under 5 years" than the 1920 census. This the present writer pointed out in the October, 1934, number of the *Geographical Review* was an appearance only, the fact beneath being that children of three and children of four, like all their elders, were more numerous in 1930 than in 1920, and only those under three were fewer in number. Further, that was true only for parts of the United States and for a part of its people, the foreign born and the children of foreign born. Whereas the natives, commonly supposed to be our delinquent class in the matter of providing the country with future sons and daughters, had more children under three in 1930 than they had in 1920.

But especially interesting to the writer is a remark of the authors touching upon what they call our "Potential Parents." "The increase that is now taking place can be attributed wholly to a peculiarity of age distribution at the present time. There is a much greater preponderance of young adults than can be expected in the future—and young adults not only bear all the children but they have much lower death rates than aged people" (p. 4).

That sounds plausible—at least as far as that the young adults are those who are to provide the children of the future—yet the figures make it appear to be a fallacy.

It is of course true that the proportion of the young has been diminishing for a long time and that the proportion of the old is always getting larger. Convenient figures are found in the Fifteenth Census (Population, Vol. 2, p. 576). We have only to do some adding of partial figures. If we call those under 20 years "young," they were 52.5 per cent of the whole population in 1850 and have steadily diminished ever since, till now they are 38.8 per cent. That is, more than half of our people were "young" in 1850 and in 1930 only a little more than a third. Meanwhile the "old," as we will call those more than 50 years of age, have increased from 8.9 per cent of the whole people in 1850 to 17.3 per cent in 1930. We have twice as great a proportion of the old as we had 80 years ago.

%	1850	1860	1870	1880	1890	1900	1910	1920	1930
Under 20	52.5	51.3	49.7	48.1	46.1	44.4	42.0	40.7	38.8
Over 50	8.9	9.3	10.8	11.8	12.6	13.3	14.1	15.5	17.3
20–50	38.6	39.4	39.5	40.1	41.3	42.3	43.9	43.9	44.0
15–50	49.5	50.1	50.0	50.1	51.8	52.2	53.8	52.8	53.4
15–60	54.3	55.1	55.8	56.3	58.2	59.0	61.0	60.7	61.1

But the really interesting numbers are those that are left. Would it be unfair to call them the Actual Parents of the nation, in the sense that most of the children born in 1930 had fathers and mothers who were between 20 and 50 years old in 1930?

Well, the number of these actual parents has been slowly but steadily increasing ever since we have had data for the facts! They are not "a much more preponderant proportion of the whole population at the present time" than they will ever be in the future, but they are a larger proportion now than they ever were before, and by all the signs they will be a still larger proportion in 1940.

In 1850, 38.6 per cent of the whole population were between the ages of 20 and 50, and now 44 per cent are between those ages. In 1910 and 1920 they happened to be exactly the same proportion of the people of the country. The numbers, of course, are increasing very much more. We evidently do not want for parents if they only have a mind to have children. Perhaps we had better call them Potential Parents instead of actual ones, so many of them have no children and do not mean to have any.

Some one of course will object that there are parents under 20, and in the past there have been many more than now. To investigate what that amounts to, we have only to set out the proportions, the percentages, for those between 15 years and 50. We may even extend the age of the potential parents up to 60 years without getting essentially different figures for the percentages, i.e. they still get larger from year to year.

That the population of the United States was slowing up its growth and had been for a hundred years was pointed out in the pages of the *Geographical Review* in 1925 (Looking Back at Malthus, Vol. 15, pp. 177–189). It was well known that the main cause was desire for a life of luxury and that it had been occurring in England, Germany, France, and other countries as well. The figures for the census of 1930 are the first that could show in addition the effects of the statutory limitation of immigration. Nor could the falling off of the birth rate for foreign families be shown except for one small item before the present census.

But it does not appear to be true that our present increase of population is wholly due to the fact that we have more young adults now than we shall have later on. Our Potential Parents are numerous enough and would be more numerous still, if they were only family-minded.

Apparently we shall presently get to a maximum population for the United States—assuming that we continue to keep out immigrants. It will be certainly for just one reason: that those who might be parents do not wish to be. If you, Dear Reader, do not like it, you might write to the *Review* and tell us how many children *you* have!

MARK JEFFERSON

The Redistribution of Population. The settlement of the frontier areas of the United States was hardly accomplished before there began a reorganization of the population manifested by the development of urban communities and a shifting of the inhabitants in the rural areas. The continued increase in numbers does not reveal the true nature of the movements that have been a feature of our population history. Beginning in 1850, the United States census has published data on the state of birth of all residents of the several states. From these data Thornthwaite (C. Warren Thornthwaite, assisted by Helen I. Slentz: Internal Migration in the United States, *Study of Population Redistribution, Bull. No. 1*, Wharton School of Finance and Commerce, University of Pennsylvania, 1934) has deduced the magnitude and the routes of migration. The analysis is essentially historical and does not venture far beyond the realm of fact finding. Much of the statistical material has been reduced to graphical form. The author has employed on most of the illustrations the spherical symbol, a volumetric device designed by Sten De Geer, which was used by the present writer in a brief study of interstate migration (Guy-Harold Smith: Interstate Migration as Illustrated by Ohio, *Bull. Geogr. Soc. of Philadelphia*, Vol. 27, 1929, pp. 301–312).

The settlement of the United States was accomplished by a great along-the-parallels migration toward the west. Even after the turn of the century, when most of the new lands were gone, the westward movement continued (J. C. Parish: The Persistence of the Westward Movement, *Yale Rev.*, Vol. 15, 1926, pp. 471–477). Thornthwaite's study of the state-of-birth data presents graphically this persistent movement. The state of California since 1900 has been the great mecca of the migrants. The transformation of the agriculture from wheat farming to the intensive

cultivation of fruits and vegetables increased agricultural opportunities. The movement included not only settlers seeking new lands but retired farmers and their wives who sought sunshine and health away from the severe winters of the interior. This host was recruited chiefly from the agricultural Middle West.

Negro migration is represented by a crosscurrent from the south. The stealthily working "underground railroad" transferred a few colored folk northward beyond the reach of their southern owners, but the number was insignificant compared with the great horde that began the northward trek about 1890. During the World War industrial expansion in the North accelerated the movement, which was not checked until the depression years set in.

Urbanization and industrial development drew rural folk from the farms and also recruited population from the immigrants and from the limited return flow from the west toward the east. By an analysis of the birth and death records by counties intrastate shifts in population are revealed. As far as the records are available they show for the decade 1920–1930 a cityward migration except for certain recently opened agricultural areas in western Kansas, in the Mississippi bottom lands, and in nearly all parts of California. Suburbanization, made possible by the development of rapid transportation, caused a decline in the central corporate city of New York. Shifts in cotton manufacturing produced complementary changes in New England, where textile towns declined in population, and in the North Carolina Piedmont, where there was an increase in numbers.

The school census was utilized to show the year-to-year shifts in population. The mobility of the population very vitally affects the school system, and the annual census of school children has been developed to check the changes in school requirements. The data may prove of much greater value as an index of the movements of the inhabitants. For purposes of illustration the author used Oklahoma, which has experienced relocations of the population because of the declining prices of wheat and cotton and the development and depletion of mineral resources.

Dr. Thornthwaite's suggestive paper based on the data on state of birth, births and deaths by counties, and the school census is a model study in population redistribution and should stimulate further research in this field. The utilities have in their files data upon the changes in services that should be of great value in the study of the relocation of people if the information could be reduced to a common date and critically analyzed.

GUY-HAROLD SMITH

El Bernal de Horcasitas, A Volcanic Plug in the Tampico Plain. A short description of "that marvellous mountain" called El Bernal de Horcasitas is given by Arnold Heim in the September, 1934, number of the *Zeitschrift für Vulkanologie*. Although only 100 kilometers northwest of Tampico, from which it is visible on a very clear day, El Bernal had not been climbed until Heim's visit ten years ago. The mountain rises from the wide synclinal plain between the Sierra Madre and Sierra Tamaulipas to a height of more than 1000 meters above sea level. The Bernal consists of a flat, circular lava shield six to eight kilometers in diameter and 400 to 500 meters in height, with a central column, one kilometer in diameter, rising another 600 meters. The walls of the column are very steep, and both shield and column are covered with dense vegetation. The shield is well preserved and must have been built by regular flows in Quaternary time; it is exactly the shape of the Hawaiian lava volcanoes; granitic blocks apparently brought up from the depths lie at the foot of the column walls; and there are traces of a crater rim. These facts suggest that the Bernal is not a residual volcanic neck but an enormous plug that must have been pushed up at least 700 meters through the cylindrical chimney after the formation of the shield.

Present-Day Conditions in the Yucatan Peninsula. Chan Kom is in the northern part of the Yucatan peninsula, 50 kilometers southwest of Valladolid. To this village

of 250 souls the Carnegie Institution devotes a volume of some 387 large pages (Robert Redfield and Alfonso Villa R: Chan Kom: A Maya Village, *Carnegie Instn. Publ. No. 448*, Washington, 1934; see also Robert Redfield: The Maya and Modern Civilization, *ibid., Suppl. Publs. No. 6*, 1933, pp. 16–29). Chan Kom, however, is broadly representative of conditions under which a large number of the inhabitants of Yucatan live. If one goes in a southeasterly direction from Merida, the only city of Yucatan, one follows declining gradients of population, economic development, and Spanish-American civilization. In the northwest, the henequen area, are the large estates, the towns, the bulk of the population, the railroads, newspapers, books; at the other end, in what was until 1932 the south-central part of Quintana Roo Territory, is a sparse population of "tribesmen," preliterate, living apart from government control, brought into outside contact only through chicle and logwood exploitation. Our village occupies an intermediate position, too far southeast for henequen, too far northwest for chicle. It is a purely Mayan, independent, illiterate, agricultural community, but it is incorporated in the state and its interests are finally directed northwestward even if essentially it is still in the stage of "face-to-face" communication. This part of Yucatan was largely depopulated in the nineteenth century and now is a new frontier. The population of Chan Kom is very young—20 per cent less than five years of age, 83 per cent less than 30—for this reason over and above the usual conditions in a primitive community characterized by high birth and death rates. The Carnegie Institution's volume with its full picture of the material and spiritual life of the community is a very "human document."

The setting of Chan Kom in the peninsula and some of its special problems may be amplified from G. C. Shattuck's "The Peninsula of Yucatan" (*Carnegie Instn. Publ. No. 431*, Washington, 1933, reviewed elsewhere in this number of the *Geographical Review*). The chapter on climate (by John L. Page) includes maps showing mean annual rainfall and seasonal distribution (the wet season, May to October) and graphs of the annual fluctuations of rainfall in Merida and Progreso. The lack of stations in eastern Campeche and the northwest of the former territory of Quintana Roo is noted. Where meteorological data are lacking the character of the vegetation is a useful guide. Mr. C. L. Lundell, who has carried out botanical explorations in the little known south-central Campeche, expresses the opinion that the region is drier than rainfall maps indicate. In "Preliminary Sketch of the Phytogeography of the Yucatan Peninsula" (Contributions to American Archæology, Vol. 2, No. 12, *Carnegie Instn. Publ. No. 436*, Washington, 1934, pp. 255–321) Mr. Lundell divides the peninsula into five phytogeographical regions. The flat northern plain is occupied by successional dry scrub forest and cultivations. The second Mayan Empire had its high development here, and from 1000 A.D. the plain has been largely under milpa cultivation. In speaking of the destructive side of this economy Mr. Lundell says: "In any treatment of the Yucatan vegetation, the destructive rôle of fires, both the seasonal ones and those of the perennial cycles can not be overemphasized. Man fells the bush in Yucatan, but his direct destruction does not compare with that which he causes indirectly by letting the fires sweep through the countryside." The remainder of the peninsula is the zone of the sapodilla, the source of chicle (compare C. L. Lundell: Chicle Exploitation in the Sapodilla Forest of the Yucatan Peninsula, *Field & Laboratory*, Vol. 2, No. 1, November, 1933, pp. 15–21). This area, which falls within the domain of the Old Mayan Empire, has been largely abandoned during the last millennium, and the forest has reached a climax stage. The large numbers of sapodilla are probably to be ascribed to the protection given to the tree by the ancient Maya, who used it for fruit, timber, and gum. Under the current system of exploitation it is rapidly vanishing. The south-central plateau is distinguished from the moister regions of southwestern Campeche on the one hand and the east coast region on the other; to the south the boundary with the luxuriant forest of northern Petén is sharply defined.

A Vegetation Map of British Honduras. A vegetation map of British Honduras on the scale of 1 : 475,000 accompanies "British Honduras: Financial and Economic Position" (Report of the Commissioner, March, 1934, *Cmd. 4586;* see abstract in *Bulletin of the Imperial Institute*, Vol. 32, 1934, pp. 376–410). The map reflects the predominant interest of the colony, four-fifths of whose exports are forest products. The rural population averages less than three to the square mile. The map shows only a small area devoted to cultivations, existing or abandoned, and the text adds the comment "in travelling through the country one comes across many signs of past enterprises, which have failed." Mangrove forests and the savana forests, wet and dry, are of no economic importance. On the map the pine forests are classed with the dry savana; for over large areas the annual fires, the curse of the milpa type of cultivation, have reduced a potentially useful timber forest to little better than savana. Rain forests, primary or secondary, occupy the rest of the country. These are the source of the present commercial exploitation, chiefly mahogany and chicle. In the swamp forest, confined for the most part to the northern plains, trees are dense but stunted and growth is exceedingly slow. Through a stage described as "intermediate forest," transition is made to "advanced forest," one of the most luxuriant in the world. Mahogany trees are of great size in this climax forest, but the stock is low, and natural regeneration is retarded by the shade. Secondary forest replaces the virgin forest on the site of the ancient Mayan cultivation: it is "doubtful whether true primary forest exists in any area suited to agriculture." Mountain forest occupies some of the least known parts of the country.

EUROPE

Three Maps of the Basel Region. Three aspects of the landscape are represented on as many maps of the Basel "corner" region where France, Germany, and Switzerland meet (G. Burckhardt: Drei Karten der Basler Dreistaatenecke, *Der Schweizer Geograph*, Vol. 11, 1934, pp. 81–92). The map of the drainage reveals a highly labyrinthine and dendritic pattern in the central core of the Vosges and the Black Forest and a parallel system in the Jura. Near the Rhine the major tributaries show an amazing absence of minor contributing streams (compare the papers by W. S. Glock, "The Development of Drainage Systems and the Dynamic Cycle," *Ohio Journ. of Sci.*, Vol. 31, 1931, pp. 309–334, and "The Development of Drainage Systems: A Synoptic View," *Geogr. Rev.*, Vol. 21, 1931, pp. 475–482). Opposite Basel and at many other places minor streams are seen to lose themselves in the alluvium, the loess, or the Muschelkalk.

In his analysis of the terrain Dr. Burckhardt lists steepness, direction of slope, and height differences, or *Reliefenergie*, as the three important elements of the physical landscape. The differences in elevation are represented by a system of dots, whose regular spacing and the resulting pattern indicate the variations in the local relief. The map, with its closely spaced dots grading into more open patterns, gives a general impression of variations in relief, but a precise interpretation is very difficult. Although 18 different gradations of relief are represented, it is not easy to distinguish between adjacent classes unless there is considerable contrast. The method employed by Krebs and the isopleth method used by Ochocka and the reviewer permit a rapid determination of the local relief in any part of the map (see this number of the *Review*, pp. 272–284). The dot system used by Dr. Burckhardt is not unlike the scheme devised by Brigadier H. St. J. L. Winterbotham to show the distribution of population in the London basin (Dots and Distributions, *Geography*, Vol. 19, 1934, pp. 211–213).

Students of democartography will find the third map, showing population density, particularly interesting for the precision in the localization of the dots for the rural inhabitants and for the system of multiple triangles for the urban centers. Areas

of greatest relief are thinly populated, but this characterization applies also to the level terrain of the Rhine graben. The settlements, both rural and urban, assume a linear arrangement in the Jura reflecting the influence of the parallel system of the drainage and the alignment of the major features of the terrain. The regular system of triangles used to represent urban settlements of a thousand or more conveys a satisfactory visual impression of the relative sizes of such cities as Basel, Mulhouse, Colmar, Freiburg, and Belfort and at the same time permits a fairly accurate determination of the population.

GUY-HAROLD SMITH

ASIA

Recent Investigations in Iran. By imperial decree "Persia" (derived from the province of Pars or Fars) gave place to "Iran" on March 22 of this year and thus restored its ancient name to the land of Jamshid and Cyrus the Great. This restoration follows the celebration last year of the one-thousandth anniversary of the birth of Firdausi (Abu'l-Qasim Mansur), author of the great epic poem, the Shah-namah or "Book of Kings" (see "Firdausi," Supplement to the *Near East and India*, Oct. 18, 1934).

The moment is auspicious for a glance at some of the recent investigations into Iranian civilization. In the first place, it should be noted that the country is being made more accessible. In 1933 and 1934 the writer traveled the old routes south of the Elburz and Jaghati mountains and as far east as Herat in Afghanistan. The ruins of ancient cities are especially numerous to the east of Sabzawar; and some of them—for instance, Nishapur, the city of the mathematician-poet Omar Khayyám—are well known. The walls of Tus, or At-Tābāran, as it was called in medieval times, more than four miles long, still rise 30 feet and more above the plain at a point eight miles by air line northwest of Meshed. In the interior of the enclosed cultivated area stand the ruins of an ancient fort or citadel, not far from which is the "Dome of Haroun-al-Raschid." Although we do not suppose that the great caliph was buried there, his remains, as well as those of Firdausi and Omar Khayyám, lie in northeastern Iran or its former domain.

A return journey from Meshed was made over one of Iran's new highways—informally opened in 1933—far north of the Elburz Range, passing through Shirvan and Bujnurd and at one place nearly touching the frontier of the Turkoman S. S. R. The route passes through an area subject to disastrous earthquakes; in some villages the destruction was found to be complete. The geological formations proved interesting and are largely unstudied.

Another new highway built by the government traverses the Caspian coast and furnishes the native merchant and the foreign tourist with a scenic motor route in what was formerly a practically continuous rice field interspersed with groves of some of the world's choicest oranges. This region is therefore not a "jungle," as some early travelers have described it, though parts of the northern mountain base farther east approach that condition. Another highway, the "Chalus road," now runs up the Karaj Valley from the city of the same name (40 kilometers or 25 miles west of Tehran) northward over one of Iran's highest passes and down to Ab-i-garm ("Warm water") in the Caspian lowlands, a mineral-spring resort where the government has recently built a good hotel.

As an offset to Russian monopoly of the trade of northern Persia, connection with the Mediterranean is effected by the Rowanduz road from Tehran via Tabriz (A. M. Hamilton: The Construction of the Rowanduz Road, *Journ. Royal Central Asian Soc.*, Vol. 20, 1933, pp. 190–202).

However, there is no lack of unfrequented ways to tempt the venturesome. Miss Freya Stark has written of her recent travels in hitherto practically unknown parts of Luristan and Mazanderan. "The Valleys of the Assassins" (E. P. Dutton & Co.,

New York, 1934) is not only a delightful narrative but a contribution to the geography and archeology of the regions concerned.

In central and eastern Iran, from the latitude of Veramin, Samnan, and Nishapur south to Yezd, Kerman, and Duzdab, from Kum and Kashan east to Nishapur, Birjand, and Lake Helmand, lies an area of more than 200,000 square miles that awaits geographical, geological, and archeological description. Little is known of the Elburz system, even from the standpoint of mineral occurrence. Some coal and other minerals are reported in restricted areas, but no appraisal has been made of their extent and value. The Elburz offers a wide field for research; for behind its frontal barrier of thousands of feet of Tertiary volcanic tuff lie numerous patches of earlier rocks—even Paleozoics in considerable areas. In addition, the range offers some excellent chances for studying overthrust phenomena and normal faulting. The altitudes of the principal peaks remain to be accurately determined. Archeological material should be searched for in caves and remote valleys.

The first contribution in many years of importance to the geology of northern Persia is made by Hans Bobek in his description of the area about Masjid-i-Sulaiman, possibly the second highest mountain of the Elburz (Reise in Nordwestpersien 1934, *Zeitsch. Gesell. für Erdkunde zu Berlin*, Dec., 1934, pp. 359–369).

At historic Persepolis Dr. Ernst Herzfeld is continuing the work of the Oriental Institute of the University of Chicago (Charles Breasted: Exploring the Secrets of Persepolis, *Natl. Geogr. Mag.*, Vol. 64, 1933, pp. 381–420). Substantial progress is being made in the restoration of ruined Achaemenian palaces. During the few years since the present writer passed that way in 1928 and took the first standard-size motion pictures of the ancient ruin the whole aspect of Persepolis has so changed that this ancient capital of Darius and Xerxes (Takt-i-Jamshid), formerly little heard of abroad, has been put on the tourist maps. Important excavations at Rhey (variously spelled Rei, Ray, Ragâ, Rhagâ, Rhages, etc.) are being undertaken by the joint expedition of the University of Pennsylvania and the Boston Art Museum under the leadership of Dr. Schmidt, who in 1931 and 1932 unearthed ancient cultures said to date from considerably before 3000 B.C. at Tepe Hissar near Damghan, 160 miles farther east (E. F. Schmidt: Tepe Hissar Excavations 1931, *Museum Journ.*, Univ. of Pennsylvania, Vol. 23, 1933, pp. 313–483).

Travelers in western Persia have taken rather unsystematic notice of what are called the "Luristan bronzes"—admirably fashioned tools and ornaments. According to latest published information, these now appear to run all the way "from 2,600 B.C. to about 530 B.C." (A. U. Pope: Dated Luristan Bronzes, *Bull. Amer. Inst. for Persian Art and Archaeology*, No. 7, December, 1934, pp. 19–21). Bronzes and great quantities of ancient pottery have been obtained at various times from other sites—in the vicinity of the Elburz Mountains and from a point southeast of Persepolis (J. M. Upton and Walter Hauser: The Persian Expedition 1933–1934, *Bull. Metropolitan Museum of Art*, December, 1934, Section 2).

In 1927, during explorations by the present writer in Tehran as well as throughout Mazanderan and Asterabad, scores of mounds were observed ranging from 20 to 100 feet in height and 100 to 500 acres in size that were obviously forts or cities. Those in the first-named province may have been part of the ancient kingdom of Rhages, or they may have been subsidiary to Veramin. Some in Asterabad are artificial mounds that are remains of cities of the Gurgan kingdom, or even a more ancient one, whereas others are natural, perhaps residual hills and subsurface intrusions of the salt-dome type. The principal mounds in Asterabad have been enumerated by De Morgan in "La Préhistoire Orientale" ([Vol. 3], Paris, 1927). One of them was excavated by F. R. Wulsin (Excavations at Tureng Tepe, near Asterābād, *Suppl. to Bull. Amer. Inst. for Persian Art and Archaeology*, Vol. 2, No. 1, bis, March, 1932). An ancient wall, the Kizil Alang (Red Wall), has been mapped by the writer (Tehran and the Elburz, *Geogr. Rev.*, Vol. 20, 1930, pp. 69–85; see Fig. 11).

All excavations in Persia are subject to, and in accordance with, the new antiquities law by virtue of which interesting relics are divided equally between the government and the institutions that finance and do the work. The present "digs" are few, however. The scant half-dozen sites, excavated or being excavated, constitute perhaps not one per cent of those that are known to exist in the provinces of Fars, Kerman, Sistan, Tehran, Khurasan, and Asterabad (the last named is now officially Gurgan). Sir Aurel Stein conducted some suggestive researches in Persian Baluchistan and on the Persian Gulf coast in 1932–1933 (Archaeological Reconnaissances in Southern Persia, *Geogr. Journ.*, Vol. 83, 1934, pp. 119–134). Painted pottery at one site (Fahreh) showed close resemblances to wares of "Susa far away in the west" and "Shahi-tump in the east." This possibility of linking the ancient civilizations of the Indus (cf. Ernest Mackay: The Indus Civilization: Some Connections with Sumer, Elam, and the West, *Journ. Royal Central Asian Soc.*, Vol. 21, 1934, pp. 420–434; and C. D. Forde: The Ancient Cities of the Indus, *Geography*, Vol. 17, 1932, pp. 183–192) with those of the Mesopotamian plain via the Iranian plateau is a powerful stimulus to further research in Iran.

FREDERICK G. CLAPP

AUSTRALASIA AND OCEANIA

The Snow Country of New South Wales. "The Snow Country of New South Wales" is an elongated plateau stretching from the borders of the Federal Territory to the Victorian border, 90 miles to the south, and 10 to 20 miles from east to west (F. A. Craft in the *Australian Geographer*, Vol. 2, No. 4, 1934, pp. 28–32). Altitudes range from less than 4000 feet in the north to 7000 feet at Mt. Kosciusko in the south. It is "a natural unit recognized by administration and occupation on account of the limited usefulness imposed by climate." The high plateau with its heavy winter snows and poor soils and vegetation is enclosed by a transition zone of steep forested slopes. A system of tenure known as the "snow lease" was established here in 1889 primarily with the object of reserving the country for stock from drought-stricken parts of the state; but the low carrying capacity limits such use, and actually a regular transhumance is practiced by graziers in the lower country to the east and west who hold the leases. The seasonal grazing occupation is of a "definitely primitive nature"; seasonal burnings to clear the pastures and open the difficultly accessible roads lead to degeneration of the vegetation and a serious erosion problem on the slopes. On the other hand, the greatest value of the snow country is as a water catchment area. "All told the potential annual value of this water is probably much greater than a quarter million sterling: according to Byles the present grazing revenue is about £2000!"

POLAR REGIONS

The Northeastern Passage of the Icebreaker "Lütke." The establishment of regular navigation along the entire length of the Northern Sea Route is at present the chief problem in the Soviet sector of the Arctic. As is well known, the first essay in this direction was made by the *Sibiriakov*, which in 1932 made the entire northeast passage in the course of one navigation season. In 1934 the icebreaker *Lütke* made the passage from Vladivostok to Murmansk in one summer (compare Leonid Breitfuss: Die Nordostdurchfahrt und ihre Erzwingung, *Petermanns Mitt.*, Vol. 80, 1934, pp. 336–338).

The *Lütke* started from Vladivostok on June 28, 1934. She stopped to coal at Petropavlovsk and at Providence Bay, at the entrance to Bering Strait. Somewhat off North Cape, recently renamed Cape Schmidt, the vessel was compelled to wait for ten days for amelioration of the ice conditions. Several flights for ice reconnoitering were made by the ship's airplane. On July 25 the *Lütke* proceeded on

her way westwards, hugging the shore of the Chukchi Peninsula, and on July 30 passed the mouth of the Kolyma River. From there to the New Siberian Islands and the mouth of the Lena River the sea for the most part was free from ice. On August 4 the *Lütke* entered Tixi Bay, where she once more replenished her stock of coal. Here harbor construction has been begun on a port for Yakutia, officially known as the "Ust-Lena Port."

On August 12 the vessel approached the Samuel Islands, off the northeast coast of the Taimyr Peninsula. Here three cargo steamers of the so-called "First Lena Expedition" had wintered. The *Lütke* found these vessels still enclosed in an unbroken land floe five miles distant. To force the 1.5-meter-thick ice proved a rather difficult task, and it was only after 112 hours of uninterrupted hard work that the *Lütke* reached the steamers.

In Vilkitsky Strait the *Lütke* met the vessels of the Second Lena Expedition, escorted on their way from Murmansk to the mouth of the Lena by the icebreaker *Ermak*, and gave them assistance.

Foggy weather and a considerable accumulation of ice in the northeastern part of the Kara Sea very much hampered the movement of the *Lütke*, and not before September 2 was she able to cast anchor at Dickson Island, where she stayed till September 14. On September 20 the expedition arrived in Murmansk.

The extent and variety of the tasks entrusted to the expedition, together with the shortness of the navigation period, limited the scope of the scientific work of which the writer was director. Nevertheless, several hydrological sections were carried out: among these the section from the Bear Islands to the New Siberian Islands is of the greatest interest. Special attention was paid to hydrochemical investigations and to the investigation of the plankton (qualitative and quantitative). In addition, observations were taken of tidal currents, waves, and the physical properties of the ice. Temperature and salinity of the surface layer of the sea were determined every ten miles along the entire route.

W. Wiese

PHYSICAL GEOGRAPHY

The Pleistocene Climate of Bermuda. It has been said of the great biologist Cuvier that, given a single bone, he could reconstruct the entire animal. In a recent paper Kirk Bryan and R. C. Cady, starting in Bermuda with wind data inferred from fossil dunes, reconstruct the atmospheric circulation of the whole North Atlantic during the Ice Age (The Pleistocene Climate of Bermuda, *Amer. Journ. of Sci.*, Ser. 5, Vol. 27, 1934, pp. 241–264).

The barometric situation of the North Atlantic at present shows a semipermanent area of low pressure near Iceland, the Icelandic low, and a persistent anticyclone, the Azores anticyclone, centered near the Azores and extending westward as a long ridge of high pressure in about 30° N. The whole system moves northward in summer and southward in winter. In summer Bermuda lies well within the anticyclonic area, but in winter it lies some distance to the north of the ridge of highest pressure. The prevailing winds are southwesterly but are generally light, especially in summer, and gales are rare. The rainfall is fairly heavy, averaging 52 inches a year according to the authors, or 58 inches according to other data; but this is distributed almost equally through the year and is due to Bermuda's situation in a warm ocean; apart from the occasional hurricanes the "cyclonic" rainfall is unimportant. At present beds of blown sand are not forming.

Most of the exposed rocks consist of eolianite, "a consolidated dune sand composed mainly of fragments of marine shells and foraminifera." The winds that formed the beds are indicated by the angles of bedding. They are described as follows: "Sayles points out that the islands have a northeast trend and lie on the southern part of the Platform. In the south and southwest parts of the islands, the cross-bedding

dips northeast and indicates southwest winds. On the north shore of the main island there is a large dune built from the north [trending north and south, an indication of its formation by strong winds], whereas, on the easternmost part of this island the cross-bedding dips southwest and indicates northeast winds. Sayles believes that the north and northwest winds were too strong to allow the preservation of dunes whereas the south and southwest winds built up the land progressively from northeast to southwest." The general conclusion seems to be that in place of the moderate southwesterly winds prevailing at present were stronger and much more variable winds, the predominant direction being west rather than southwest. Of course, only the onshore winds have left a record. Not only must the winds have been stronger than at present, but there must also have been a suitable surface from which the material for the dunes could be collected. Bermuda rests on an extensive submerged platform; a depression of sea level two or three hundred feet would expose this to the action of the wind. Such a depression occurred several times during the Quaternary, as a result of the locking up of large quantities of water in the form of ice. Furthermore, the eolianite series is broken by several fossil soil formations; these can be correlated with periods of ice recession during which the submergence of the platform and the decrease of wind velocity both operated to cause the cessation of dune formation. This explanation of the series, which was first put forward by R. W. Sayles, appears to be fully justified. The more important soils, which were formed by leaching of the eolianite, represent interglacial periods; but two minor soils, whose constitution shows that they were formed by the slow accretion of wind-borne material, probably represent minor retreat stages within a glaciation (see R. W. Sayles: Bermuda during the Ice Age, *Proc. Amer. Acad. of Arts and Sci.*, Vol. 66, No. 11, 1931, pp. 381–467).

The authors make a detailed study of the way in which the lowered sea level, the influx of icebergs, and other factors probably influenced the North Atlantic circulation, and they conclude that, as regards Bermuda, the general effect was a shift of the climatic zones some five degrees southward. This made the climate of the Glacial summers similar to the present winter climate, while the winter climate was severer. The climate as a whole was both cooler and windier than at present. The low-pressure area centered southwest of Ireland and the anticyclonic ridge well to the south of Bermuda. The generalized storm tracks pass fairly close to the northwest of the islands; this accounts for the greater variability of the winds. The strong northerly winds may well have resulted from the nearness of the great American ice sheet.

It must be more than a coincidence that this reconstruction agrees almost exactly with a recent reconstruction by Dr. G. C. Simpson of the winter conditions according to his theory that the Quaternary glaciations resulted from variations of solar radiation (World Climate during the Quaternary Period, *Quart. Journ. Royal Meteorol. Soc.*, Vol. 60, 1934, pp. 425–478; reference is to Fig. 6). Both show the low-pressure area and the anticyclonic ridge in almost identical positions, while the main storm tracks follow similar lines. There can be little doubt that with this representation we have arrived at something very near the truth. The chief point of criticism is the position of the low-pressure area: considering that the present drift of warm water across the Atlantic must have been almost, if not completely, suppressed during periods of maximum glaciation, it would seem probable that the low-pressure center, or at least an extension of it, lay much nearer the American coast and considerably farther south than is shown by either reconstruction. This is borne out by the great variability of the winds over Bermuda during glacial maxima—much greater than could be expected from Bryan and Cady's reconstruction.

The succession in Bermuda does not give much information about the rainfall. Bryan and Cady assume that during periods of ice advance the rainfall was about

the same as at present and remark that coastal dunes can form in the presence of vegetation. With more northerly winds and a great ice sheet to the northwest, the rainfall may have been less than at present; with cold air currents warmed from below during their passage over a warm sea, the rain would certainly have been of a more unstable character, falling in violent showers that would run rapidly off the land. The real importance of Bermuda in the study of past climates is the information it gives on the Glacial winds. Such data are the most enlightening of all to the meteorologist, but unfortunately they are very rare.

C. E. P. Brooks

METHODOLOGY

Technique in Geographical Field Studies. During the past decade American geography has moved vigorously in the direction of greater precision in technique. This has expressed itself primarily in regional geography, specifically in studies based on investigations in the field (compare Derwent Whittlesey: Field Study of Human Geography in the United States, *Comptes Rendus Congr. Internatl. de Géogr., Paris, 1931*, Vol. 3, 1934, pp. 774–778). Contributions of note to the subject were made at the 1933 and the 1934 meetings of the Association of American Geographers. At the former a session was devoted to the topic "Conventionalizing Geographic Investigation and Presentation" (see *Annals Assn. of Amer. Geogrs.*, Vol. 24, 1934, pp. 77–122; also *Geogr. Rev.*, Vol. 24, 1934, pp. 309–311); at the latter the topic was "A Conference on Regions" (see the report in this number of the *Geographical Review*). These dealt primarily with principles. By way of concrete examples we have Vernor C. Finch's paper on Montfort, southwestern Wisconsin, and Robert S. Platt's paper on Magdalena Atlipac, Mexico, in a volume entitled "Geographic Surveys" (*Bull. Geogr. Soc. of Chicago, No. 9*, 1933). Professor Finch precedes his paper with an explanation of the method and technique employed in his field work. The area of his investigation covered 47 square miles, and the "specific facts of geographic significance" determined for it number 20,000. They were recorded on a base map of 1 : 15,840 scale in the form of a "fractional notation." In this notation the numerator is composed of index numbers representing major use type, specific crop or use type, and condition of crop, and the denominator represents slope of land, soil type, and condition of drainage. The map is reproduced in black and white on a scale of 1 : 23,760. A series of maps on a smaller scale show the various elements mapped separately.

Professor Platt's paper is another "microscopic" study. His investigation of Magdalena Atlipac covered four square miles. "Fractional complex mapping of this area discloses several hundred complex spots, which combine to form four or five types of land with characteristic types of utilization." He concludes by depicting this little community as one cell in a greater areal social organism of which the physical body is the Valley of Mexico, which in turn is one of many similar organisms in the Central Plateau of Mexico. He thus establishes a correlation between details for a small district and generalizations over large regions.

Students of the technique of field studies in regional geography will be repaid by examination of "The Santa Clara Valley, California: A Study in Landscape Changes" by J. O. M. Broek (Utrecht, 1932). It is as interesting for its matter as for its method, but we must content ourselves with referring to the latter by two quotations from the author's introductory chapter: "The study of the origin and transmutations of landscape elements is so interwoven with past processes and land patterns that an appreciation of their significance becomes impossible if they are isolated from their earlier assemblages. Thus, the intricate complex of forces—which may be indicated here as the *social-economic determinants*—active in and characteristic for each time span, must be analyzed and its areal reflection—the *landscape*—reconstructed in its main aspects." "As the entire region was too extensive for detailed mapping, three

sections, each typical for a different portion of the valley, were chosen. For each of these sample areas, data were gathered for the present time, and, as far as available for the earlier periods. By a reconnaissance of the entire valley, and by an examination of literature, the findings for these representative areas were generalized for wider regions. For this reason, the sample areas are not treated here in detail; their function for the writer is as a working tool; for the reader they may serve as illustrative material. Thus, several maps of the three specimen areas have been added to this paper, thereby presenting cross sections of the valley, not only in sense of area, but also in sense of time."

GEOGRAPHICAL NEWS

The American Society of Photogrammetry and the International Photogrammetrical Congress. Geographers have always realized the importance of pictorial representation as an aid to description. They have also used maps for the same purpose where such were available. It is only in the last decade or so, however, that the importance to them of maps made from photographs has even begun to be appreciated. The question may well be asked in what way does the photogrammetrically made map differ from that made by conventional methods. To answer briefly, photogrammetry makes it possible to collect the material for extremely detailed mapping or for extensive mapping over large areas in the least possible time and then allows a selection to be made of pertinent detail to be mapped after the significance of the field observations as a whole has been realized. At present the cost of photogrammetrical mapping is out of all proportion to the cost of the average small geographical field trip; but the art is still young, and methods are continually being improved and simplified. Thus it is within the bounds of possibility that soon light photogrammetrical instruments will become the standard photographic equipment of the geographer in the field, and it will be a part of every geographer's training to learn the theory and practice of photogrammetry.

An indication of the awakened interest in the subject in this country is the recent organization of the American Society of Photogrammetry in Washington, D. C. Among the objects of this Society are to advance knowledge in the science of photogrammetry and to act as a clearinghouse for the distribution of information pertaining to the science. Colonel C. H. Birdseye of the U. S. Geological Survey is the president, and Colonel J. W. Bagley and Lieutenant O. S. Reading of the U. S. Coast and Geodetic Survey are vice-presidents. The American Society of Photogrammetry has been admitted to membership in the International Society of Photogrammetry, which held its Fourth Quadrennial Congress in Paris at the end of November, 1934.

The American Geographical Society was officially represented at the International Congress by Miss Louise A. Boyd, who was one of five official delegates from the United States. The following is abstracted from her report (see also the Report of the Fourth Quadrennial Congress of the International Society of Photogrammetry, by O. S. Reading, in the January, 1935, *News Notes* of the American Society of Photogrammetry).

The International Congress was opened in the presence of the President of France, M. Albert Lebrun, and was presided over by General Perrier, president of the International Society and president of the Société Française de Photogrammétrie. Twenty-six countries were represented by 366 delegates, the French delegation being by far the largest. Germany, Switzerland, Italy, and Poland were also well represented.

The activities of the Congress, in addition to the reading of numerous scientific papers on the various theoretical and practical aspects of the subject, consisted in the display of photogrammetrical instruments and equipment and the exhibition of results in the form of maps and photographs. Many of the scientific papers will

appear in a few months in Part 2 of Volume 8 of the *Internationales Archiv für Photogrammetrie* (Baden near Vienna). There was a very full display of instruments by the various countries, especially France, Germany, Switzerland, and Italy, and reference should be made to Lieutenant Reading's report in this respect.

Perhaps of most interest from the geographical point of view was the exhibition of maps actually made by photogrammetrical methods. On viewing the exhibits one was first impressed by the excellence of their presentation. Most of the maps were accompanied by selections of photographs used in the mapping and by diagrams showing the trigonometrical control and general reliability, and they were also accompanied by full explanations printed in large type.

The detailed expression possible in photogrammetric maps is such that new problems of representation and reproduction have arisen, and very significant features of the exhibits were the attempts made to differentiate types of land forms by hachuring devices and by the employment of various kinds of contours. For example, in the French section was a map of Saint Christophe-en-Oisans on a scale of 1 : 20,000 with 10-meter contours, executed by the Service Géographique de l'Armée, in which ten different types of contours were shown.

The many and varied uses to which photogrammetry has been put in all parts of the world also impressed the visitor. Exhibits included, to mention but a few, stereoscopically plotted details of a street accident in Switzerland, a map on the scale of 1 : 5000 of the cone of Mount Etna, cadastral maps from Madagascar, town plans in Chile, and topographical maps of Iceland on a scale of 1 : 100,000. There were also four examples of exploratory mapping by photogrammetric methods in the Arctic, including the maps published by the American Geographical Society of the Louise A. Boyd Expedition to East Greenland in 1933.

Noteworthy among the exhibits of photographs were those in color made from an airplane with a special camera built by Photogrammetrie, Munich. These were exceedingly clear in definition and very true in color: ground, forests, fields, etc. were easily distinguished and seen in great detail. Pairs of overlapping colored photographs when examined in a stereoscope showed that the introduction of color was of great aid in the analysis of land forms, geological features, vegetation, and the like.

It is proposed to hold the next International Photogrammetrical Congress in Rome in 1938 under the presidency of M. Cassinis, director of the Engineering School at Milan.

OBITUARY

Frederick Samuel Dellenbaugh. When Major Powell planned his second descent of the Colorado in 1871, he chose as a member of his small party a lad of 17, Frederick S. Dellenbaugh. With the death of Mr. Dellenbaugh on January 29 of this year the last living link with that great feat of American exploration is severed. The first considerable narrative of the journey is Mr. Dellenbaugh's own account, "The Great Walled River" in the *Bulletin of the American Geographical Society* (Vol. 19, 1887). A vivid narrative it is, for the author was an artist with the pen as with the brush. "The river narrows and vanishes from the sight through the most magnificent portal in the world; the barren red rocks lifting themselves two thousand five hundred feet straight into the sky . . . the subtle river, deep and swift and smooth, hurried us into the majestic depths, and silently closed the giant gates of rock behind. . . . Nothing could be more striking in contrast than the delicate colors of a fading sunset, seen only in the zenith, and the dark shadows filling the deep chasm and fairly quivering with the reverberations of the tortured river . . . ever descending with terrible velocity along with the furious flood, the din of the reverberating roars filling the cañon, fairly stunning the ear, and seeming to batter against the fair blue sky spanning from brink to brink, nearly 4,000 feet above."

Some chapters were devoted to the journey in "The Romance of the Colorado River" (1902; 2nd edit., 1906; 3rd edit., 1909), and it was treated at full length in "A Canyon Voyage" (1908; 2nd edit., 1926).

Small wonder was it that the young Dellenbaugh with his artist's appreciation was won to the West. In the Preface to "Breaking the Wilderness" (1908) he says: "With the Wilderness, however, I can claim some degree of familiarity, for I . . . have been over portions of almost every one of the principal historical trails. I have travelled there on foot, on horseback, by boat, by waggon, and by railway . . . I have lived under its open sky through summers and through winters; its snows, its rains, its burning heat, have baptised me one of its children. In some cases my footsteps have been among the first of our race to break the surface; and if I have not visited every nook and corner of it during the last thirty four years it is the fault of my purse, not of my spirit."

He found interest, too, in tracing the footsteps and fortunes of his predecessors. "The True Route of Coronado's March" (*Bull. Amer. Geogr. Soc.*, Vol. 29, 1897, pp. 399–431) is one of his historical papers, and he compiled the chapter on Travellers and Explorers from 1846 to 1900 for the Cambridge History of American Literature. His lives of Frémont (1914) and of Custer (1917) are tributes of admiration and understanding. The Indian, too, was to him not "an abnormal factor, but rather a natural part of our society." Doubtless something is owing here to Major Powell "whose foresight established the Bureau of American Ethnology" ("The North-Americans of Yesterday," 1901). Other parts of the world claimed Mr. Dellenbaugh's attention also. He painted from Alaska (as artist on the Harriman Expedition of 1899) to Finistère, "the 'Wild West' of France" (see *Bull. Amer. Geogr. Soc.*, Vol. 20, 1888, pp. 295–336).

Mr. Dellenbaugh long had connections with the American Geographical Society, and from 1909 to 1911 he served as its librarian. He was a founder of the Explorers Club of New York and a moving spirit in its activities. Among other things, he edited the facsimile edition of the Scoresby Log Books, a contribution of great value (compare *Geogr. Rev.*, Vol. 15, 1925, pp. 490–491). However, he remained faithful to the West. He was fond of reminiscences of the early days, but he was not content until he had made a record of the remembered items, and the Society has received from him many letters, the last dated January 13 of this year. Accuracy of detail became almost a passion with him. He not only achieved accuracy in himself but he inspired it in others by persuasion and sweet reasonableness. The beauty that he sought to capture and portray on canvas shone also through his speech, his manner, and his writings. Included within the scope of his versatility there was also a rare genius for friendship.

GEOGRAPHICAL REVIEWS

The Problem of Life in the Tropics

George Cheever Shattuck and others. **The Peninsula of Yucatan: Medical, Biological, Meteorological and Sociological Studies.** xvii and 576 pp.; maps, diagrs., ills. *Carnegie Instn. Publ. No. 431*, Washington, 1933. 12 x 9 inches.

This report deals with three expeditions to Yucatan by the Department of Tropical Medicine of Harvard University under the auspices of the Carnegie Institution and is part of the great panscientific plan of the Carnegie Institution to study one of the culture hearths of aboriginal America.

With a specific regional focus of the medical field studies, the present volume throws much light on the whole problem of life in the tropics and is invaluable to anyone concerned with such questions. The presentation mingles formal, systematically reported clinical investigations with many informal notes on nature and man. Data that found no place elsewhere are put into an initial chapter called "Miscellaneous Information"; midway in the volume the reader encounters a chapter on "Life in the Forests of Quintana Roo," in which the physician sets forth with fidelity and simplicity his trips among the *chicleros* of the backwoods; toward the end is a set of botanical notes on the dry forest of Yucatan and the destructive influence of man. No small part of the value of the studies lies in these significant asides, which by good fortune escaped editorial excision. Dr. Shattuck and his associates indulged freely in macroscopic inspection of their region with an acuteness that anyone can recognize who is familiar with Mexico or Central America. Text passages and photographs give an intimate and realistic picture of life in Yucatan that is excellent human geography. Particular communities are described in detail not only as to their sanitary facilities or the lack thereof but as to the kind of houses and their furnishings, the food and its preparation, the crops and modes of tillage, the use and food of domestic animals. "Candid shots" are numerous; for instance, it is related of the amusements of one village that dancing is often indulged in and sometimes the people drink chocolate. Could anyone say more in a sentence about standards of living and social life?

Ricketson and Redfield contribute valuable anthropological sections. On the clinical side, determination of the great simplicity of blood groups may be noted: 97.7 per cent of the Indian subjects were in Group O, and even 85 per cent of the mestizos fell in this group. Surprisingly, the rates of basal metabolism were found to be high, in contrast with the familiar Indonesian results. Margaret M. Hilferty and Helen C. Maher exploit skillfully the available vital statistics. Three districts gave the extraordinary birth rates of 43.2, 44.2, and 48.2, and the rate in one of these in the most favorable year rose to 54.8. Deaths caused by malaria and intestinal infections are analyzed in terms of their seasonal frequency and in relation to monthly temperature and rainfall.

Clinical studies were concerned primarily with dysentery and related infectious diseases of the intestinal tract, which cause about a third of all deaths. The human intestine in Yucatan, as viewed by way of the microscope, becomes a fascinating chamber of horrors. "So many kinds of organisms are found that immunological prophylaxis does not seem to offer a remedy for the situation, and it is believed that nothing short of the most vigorous sanitary measures would be effective. Intestinal infections are so common that the fatalistically minded people have little fear of them, and many years would be required for sanitary education. With such a variety of intestinal infectants, *in addition to protozoa* [italics by the reviewer], the number of cases and of deaths due to gastro-intestinal disturbances in Yucatan is not a cause for wonder. The astonishing thing is that under such conditions any one survives his childhood. Perhaps this very fact accounts for the sturdy physique of the

Maya . . . " Contaminated water from wells and *cenotes* (sinks) is found to be the principal cause of such infection. Later expeditions of the same group have been carried on in the highlands of Guatemala, where streams are the principal source of domestic water. Their findings on the danger of such water supply as compared with the situation of Yucatan will be awaited with interest.

By way of contrast, malaria in Yucatan appears to be a less serious problem than might be expected. The evidence on syphilis among the Mayas is that it is very mild and not common. An interesting review of the history of the disease is included and of its relation to race and climate, with special reference to racial resistance or partial immunity.

For every disease that has become endemic the historical and archeological evidence is considered because of the desire to know the bearing of indigenous and Old World diseases on the course of Mayan civilization. The authors are inclined to regard subtertian and quartan malaria as diseases brought in from the Old World in colonial time. Modern commerce has definitely increased the number and danger of infectious diseases. It may be inferred that this corner of the tropics was much healthier and happier before it was brought into contact with the world at large. It is greatly to be hoped that this group of medical scientists may have occasion to carry on similar surveys in parts of the New World tropics that have thus far had little and infrequent contact with the outside world. Even in their present study there is recurrent suggestion that the ills of the American tropics are closely related to the mobility of man.

CARL O. SAUER

SOIL EROSION IN WISCONSIN

MELVILLE H. COHEE. **Erosion and Land Utilization in the Driftless Area of Wisconsin.** Map, diagr. *Journ. of Land & Public Utility Economics*, Vol. 10, 1934, pp. 243–253.

The basis of this discussion is a study of 30 representative farms in the town of Webster, Vernon County, Wis. These farms, covering a total of 3290 acres, have within their borders about 14 per cent of the land area of the town. The method of sampling within the unit area is commonly followed by the agricultural economist; it differs in this respect from the geographic mapping approach as exemplified by V. C. Finch's study of the Montfort community in the Driftless Area. Effort was made in the selection to obtain a representative sample of the utilization of all types of Driftless Area land—valley bottoms, steep slopes, and ridge tops. Factors of slope, soil, and crop complex are strongly emphasized, and an idealized cross section from valley bottom to hilltop is presented, with the distribution of land coverage (permanent pasture, woodland, hay, corn, oats, etc.) given in percentages by per cent of slope. Extensive tables summarize the statistical calculations and present the inventory of land cover on the 30 farms.

The general and specific factors influencing soil erosion in the Driftless Area are discussed. The erosion problem is complicated in the region because the runoff of the ridge lands becomes the eroding agent of the valley lands. This fact is related to the specific land-use problems, wherein 70 per cent of the land of the 30 farms consists of ridge lands and hillsides that shed water and debris on the 30 per cent of the valley lands. The author, assuming that the 30 farms are fair samples of the 36 square miles of the town, estimates that 19,576 tons of soil are lost annually by erosion.

The article closes with a discussion of possible public policies for erosion control. Local, state, and federal governments are affected by the blocking of highways by alluvial fans, the washing out of bridges, and the spoilage of streams. The physical aspects of soil-erosion control are complicated by the interdependence of ridge and valley farms. Social aspects of control are also complicated. For example, timber and pasture lands in the town are too highly taxed compared with cultivated land.

Of particular value for the geographer are the data on quantitative measurements of erosion. These relate not only to cover and slope of the land but to such erosion-promoting factors as the length of field.

The sample chosen is perhaps too small to be indicative of conditions throughout the entire Driftless Area, with its diversity of bedrock and stage of maturity, but it is representative of the rough central portion of the area and is another contribution to the regional aspects of land use and erosion.

LOYAL DURAND, JR.

THE BRITISH COLONIAL EMPIRE

An Economic Survey of the Colonial Empire (1932). Issued by the Colonial Office. vi and 575 pp.; indexes. *Colonial No. 95.* His Majesty's Stationery Office, London, 1934. £1 5s. 13 x 8½ inches.

In the Government of the United Kingdom the Secretary for the Dominions is in charge of the relations with the other self-governing states of the empire; the Secretary for India is responsible for the government of the Indian Empire and the territories in southwestern Asia associated with it; and the Secretary for the Colonies is responsible for the rest of the overseas empire except for a few anomalous territories, such as the British-Egyptian condominium of the Eastern Sudan, which is dealt with by the Secretary for Foreign Affairs. Also, some of the dependencies are under the control of other dominions. These somewhat complicated arrangements are the result of growth, not of any definite scheme of organization. In official reports the word "colony" now denotes one of the group of dependencies administered by the Colonial Office. The volume under review deals only with these "colonies," to which it limits the term "Colonial Empire."

Part I (pp. 1–387) is a series of memoranda on the separate colonies, grouped for convenience under six great areas, namely East Africa, West Africa, Eastern (from the Seychelles to Hongkong), Mediterranean, West Indies and America, and the Western Pacific. There are some fifty of these articles, all arranged on a uniform plan with ten numbered sections devoted respectively to position, area, and land ownership; population; finance; trade statistics; natural resources; industry; other economic activities, e.g. tourist or entrepôt trade; communications; tariffs; and trade representatives. For the most part this section may be described as an annotated catalogue. In some special cases it is very illuminating. The accounts of the trade of Hongkong and Singapore, for instance, give precise meaning to the usually vague concepts of entrepôt trade and entrepôt port.

Part II (pp. 388–457) consists of twenty-two memoranda on the principal products of the Colonial Empire. It was not possible to make these as uniform in plan as the series in Part I; but most of them give an account of the methods of production or extraction, varieties or grades of products, the world production and consumption, and the colonial production. Part II is almost an encyclopedia of the economic products of intertropical lands, since the character and distribution of the British colonies are such that the list is practically coextensive with that for the intertropical regions as a whole.

A third section (pp. 458–568) is occupied by 36 statistical tables, which list the exports from each of the territories of the Colonial Empire to the United Kingdom, to the rest of the British Empire, and to foreign countries, by both quantity and value, for the years 1929, 1930, 1931, and 1932. We are told in the preface that future editions will be published as soon as the required statistics can be assembled, even before they have been published elsewhere.

The lands of the Colonial Empire occupy an area of 1,860,000 square miles, about one-seventh of the total area of the British Empire; and they contain about 57,000,000 inhabitants, one-ninth of its population. The intertropical and subtropical

location of the colonies (with the single exception of the Falkland Islands) gives them important climatic characters in common. They include great commercial emporiums, such as Hongkong and Singapore, and intensively cultivated one-crop garden lands, such as Zanzibar, the island of cloves, Barbados and Mauritius with their cane sugar, Dominica with its lime fruit, and Tonga with its coconuts. There are great plantation areas in Malaya, Ceylon, and East Africa; populous areas of small-scale native agriculture for subsistence and for some export products in Ceylon, Uganda, and West Africa; and many large areas of undeveloped land. The characteristic economy is that of primary production of raw materials. Agricultural and mineral products are of chief importance; but there is also a considerable output of pastoral, forest, and fisheries products.

The greater part of the Colonial Empire is in East Africa, where the contiguous territories of Kenya, Uganda, Tanganyika, Nyasaland, and Northern Rhodesia together occupy a little more than half its area and hold a little less than a fourth of its population. The next largest area is Nigeria, which is also the most populous unit, with nearly twenty million inhabitants, a third of the total, on about 373,000 square miles of land. The Colonial Empire includes four smaller continental territories, the Malay Peninsula, British Guiana, British Honduras, and Gibraltar, and a very large number of small islands in the West Indies and in the Indian and Pacific oceans. The island colonies bulk very large in the history of the empire; and they have in fact a much greater relative importance than their small size (less than 16,000 square miles in the aggregate) suggests.

The volume may be described as the standard book of reference on two subjects: the territories described and economic products of tropical and equatorial lands. It also includes much information on the commercial relations between these and the temperate lands.

C. B. FAWCETT

MONGOLS OF MANCHURIA

OWEN LATTIMORE. **The Mongols of Manchuria: Their Tribal Divisions, Geographical Distribution, Historical Relations with Manchus and Chinese, and Present Political Problems.** 311 pp.; maps, bibliogr., index. The John Day Company, New York, 1934. $2.50. 7½ x 5 inches.

Mr. Lattimore's latest book forms a contribution of outstanding importance to our knowledge of the ethnic, economic, and political problems awaiting solution in eastern Asia today.

The book falls naturally into two parts. The first six chapters treat of that large section of the Mongol people dwelling in Manchuria in their broader relationships—with their fellow Mongols elsewhere, with the Chinese, with the Russians, and now with the Japanese. The remaining ten chapters discuss their situation, past and present, in more detail, describing among other matters their social and political organization in tribes, leagues, and banners.

Mr. Lattimore makes clear the significance of the creation of the new state of Manchukuo. This, he shows, although essentially Chinese in character, has nevertheless a strong regional consciousness. He points out the extremely important strategic character of its frontiers and shows how the Mongols within its borders are able, through their geographical position, to exercise great and perhaps decisive influence in the event of hostilities in eastern Asia. Mr. Lattimore's analysis of these aspects of his subject is at once penetrating and authoritative.

Perhaps the chief interest of the book to most readers will be the account it gives of the expropriation by the Chinese of much of the Mongol territory in Manchuria, under the guise of "colonization." The author emphasizes something that Occidentals in general fail to realize—that the political structure that fell in 1911 was not a Chinese but a Manchu empire. The Mongols were not subjects of a Chinese ruler.

Very much to the contrary, they, along with the Tibetans, the Manchus, the Mohammedans of China (although now very closely assimilated to the native Chinese, still considered by the latter as a separate people), and the Chinese themselves, owed allegiance to the Manchu emperor. This is an indisputable historical fact, however much Chinese writers may try to gloss it over.

After the revolution of twenty-three years ago the Chinese at first proclaimed a federal union in which all five peoples were to be on an equal footing. But later they quietly abandoned this position and began to treat their associated peoples as subjects, to be exploited. Without any historical or legal justification whatever, they declared that the Mongol lands belonged to the Chinese people, who consequently had the right to occupy them. Stress is rightly laid on the part played in the process of land-grabbing by the building of railroads. For the railroads have not only rendered the Mongol lands easier of access; they have made seizure of these lands worth while by making economically profitable the transport to distant markets of the produce that can be grown on them. Mr. Lattimore also shows how the rapacity and injustice of the Chinese official class, exercised not only against the Mongols but also upon their own people, made for the ease with which the four Manchurian provinces were detached from China proper and established as an independent state in alliance with Japan.

An interesting point brought out by Mr. Lattimore is that the Mongol princes, because of their jealousy of one another, are the readier to acknowledge allegiance to P'u Yi, the legitimate heir of those powerful Manchu emperors to whom their fathers and forefathers paid homage. The recent elevation of P'u Yi to the throne of Manchukuo may therefore, as Mr. Lattimore suggests, have far-reaching effects through its influence upon political alignments throughout eastern Asia, where the Mongols hold a key position.

"The Mongols of Manchuria" is written in Mr. Lattimore's usual clear and readable style. The book is furnished with fine maps, based in part on the admirable work of Japanese cartographers; and it has an excellent bibliography and a carefully prepared index.

C. W. BISHOP

TRAVELS IN CENTRAL ASIA

ELEANOR HOLGATE LATTIMORE. **Turkestan Reunion.** xi and 308 pp.; map, ills. The John Day Company, New York, 1934. $2.75. 8 x 5½ inches.

"Turkestan Reunion" is a wholly delightful book. Mrs. Lattimore has the gift of sharing with her readers her keen pleasure in the places she visits and the people whom she meets along the road. Her deftly drawn word pictures stand out like vignettes, and her powers of accurate and detailed observation are altogether exceptional. Her presentation of her subject in the form of familiar letters adds greatly to the personal and subjective character of her account of her journey.

Mrs. Lattimore's route took her, in the depth of winter, by rail from Peking (as it then was) through Manchuria and across Siberia as far as Semipalatinsk. Thence she traveled by sledge four hundred miles to the border town of Chuguchak. There she was met by her husband, who had made the journey through Mongolia and Chinese Turkestan by camel caravan; and thence the two traveled to Urumchi. From Urumchi a side journey was made to the depression of Turfan, famed for its summer heat, its melons and grapes, its ruins of forgotten cities and ancient Buddhist shrines. Thence back to Urumchi, and so to Kulja, through country made dangerous by bandits—Kirghiz who raid across from Russian territory.

During their journey, the travelers indulged in a delightful little hunting trip high up in the Tien Shan, the "Heavenly Mountains." At Kashgar they found an oasis of civilization in the British consulate. From Yarkand across the mountains to Leh, their goal at the gate of British India, required a month of the hardest sort of travel

over lofty passes, five of them above 16,000 feet in height. Mrs. Lattimore's picture of the yaks glissading down the ice slide at the Khardong Pass is amusing and reminds the reader—as, for that matter, much in her narrative does—of Abbé Huc's account of his travels. Shortly afterward the Lattimores reached Leh, with its tourists and artists, and felt themselves back once more in civilization.

Mrs. Lattimore's chapter headings are inviting, and so too are the illustrations by Eleanor Frances Lattimore. In short, "Turkestan Reunion" is a book to be cordially recommended to all classes of readers.

C. W. BISHOP

CRUSTAL MOVEMENTS IN SOUTH AFRICA

ALEX. L. DU TOIT. **Crustal Movement as a Factor in the Geographical Evolution of South Africa.** Map. *South African Geogr. Journ.*, Vol. 16, 1933, pp. 3–20.

Although South Africa has escaped severe folding in late geological time, practically all parts have suffered uplift and warping on a large scale since the middle of the Tertiary period. Much of the great interior plateau is in the initial stage of dissection. Marine terraces and associated sediments that fringe the coasts show that the old continental platform has been involved in the uplift.

Axes of recent warping, which trend generally northeastward, are traced by their various effects on drainage. Ponded streams have endeavored to adjust their disturbed gradients by silting up depressions and by incising their valleys sharply across axes of uplift. In some areas the drainage has been dismembered or even reversed by rapid warping. Du Toit considers these effects a comparatively mild expression of the general forces that farther north produced the great rifts. The position of primitive human relics indicates that considerable crustal movement has occurred since ancient man appeared in the region.

Radical climatic changes have attended the various changes in level. Rising of the great plateau has made a wide area in and near the tropics habitable to white men. Erosion of this high country is exceptionally rapid. Du Toit estimates that the Orange River basin is being lowered at the rate of one foot in 1500 years.

CHESTER R. LONGWELL

AN OLD METROPOLIS OF THE SUDAN

CHARLES MONTEIL. **Une cité soudanaise: Djénné, métropole du delta central du Niger.** vii and 304 pp.; maps, diagrs., ills., bibliogr. (Institut international des langues et civilisations africaines.) Société d'Éditions Géographiques, Maritimes et Coloniales, Paris, 1932. 9½ x 6½ inches.

Jenné has long played an important role in the western Sudan, both in its own right and by virtue of the centers it has created or nourished, notably Timbuktu, its outpost for the great Saharan salt trade. Jenné has inherited a business tradition that comes from the remote past, the old empire of the Mellé. It is an old town of curious architecture. The unit Jenné-Timbuktu has been for centuries the commercial heart of navigation and trade on the bend of the Niger.

The economic changes brought on by the French occupation are causing the slow but certain disappearance of Jenné. Situated on a side channel (*marigot*), it is not accessible for small steamboats. The port of Mopti, created during the war, on an island in the main stream, has drawn away river commerce. Moreover, the administrative capital has been set up at Bamako, for which Kulikoro is river port. Near Kulikoro the dam of Sotuba and the great irrigation works are bringing about the birth of an entirely new economic center. Jenné is thus fading out of the picture. M. Monteil, who has governed it many years, describes the old town while something still remains.

E. F. GAUTIER

The East African Lakes and Their Fisheries

S. and E. B. Worthington. **Inland Waters of Africa: The Result of Two Expeditions to the Great Lakes of Kenya and Uganda, with Accounts of Their Biology, Native Tribes and Development.** xix and 259 pp.; maps, diagrs., ills., bibliogrs., index. Macmillan and Co., London, 1933. 15s. ($6.00.) 9 x 6¼ inches.

Lakes occupy 33,000 square miles of surface in Kenya Colony and Uganda. The tropical waters have a high productivity, the food supply for fish is abundant, and the need of developing this resource for human food is great: how can the waters adequately be "farmed"? "Inland Waters of Africa" furnishes a preliminary answer to the question. It is an answer that will be interesting to many people; for the authors have successfully combined the "popular" and the "scientific" in this pleasant volume (detailed scientific results are being published in scientific journals, see Appendix). Part of the reader's pleasure doubtless lies in the diversity of scene and the variety of material at the authors' disposal. The larger lakes all have an interesting individuality. Lake Edward is the deepest (nearly 400 feet), and it exhibits a feature hitherto unrecorded for tropical lakes, a thermocline at 25 fathoms. Lake George is so shallow that "an elephant could walk all over it, keeping its head above water." The smooth swamp-bordered shores in their flat, hot setting afford an extreme contrast with the lava-dammed highland lake of Bunyoni, picturesque as a Scottish loch. And with the people as with their country. There is, for instance, a graphic contrast between the busy salt mart of Katwe, to which come natives from all over Uganda, and the primitive fishers of the floating papyrus islets of Lake Kioga, who have no connection with the mainland.

Lake Rudolf of the storm-swept waters (two members of the Lake Rudolf-Rift Valley Expedition under V. E. Fuchs lost their lives on the lake in 1934) is perhaps the most interesting because the least known. Here the Worthingtons trod virgin ground on Crocodile Island in the center of the lake. The island is the remnant of a volcanic cone with secondary vents. The main crater and two secondary ones are occupied by lakes. The first lake, cut off by a 200-foot wall, has no fish; the second, separated from the main lake by a 20-foot ridge, has fish so different that they are classed as a new species; the third lake, cut off by only a few feet of shingle, has fish like those of the main lake except that they are stunted. Lake Rudolf itself lies in an enclosed drainage basin. Although its waters are alkaline, it supports a wide range of fish that are almost but not quite identical with those of Lake Albert and the lower Nile. Old shore terraces built when the lake drained to the Nile can be traced, and J. H. Driberg, one of the few travelers in the Kenya-Uganda-Sudan border country, has reported the existence of a dry connecting channel across the present watershed. Lake Edward is singular in the complete absence of crocodiles, which are stopped by the barrier of the Semliki Falls. The occurrence of fossil crocodiles in old beaches of the lake points to extinction in an interpluvial period when the lake presumably dried up.

Study of lake ecology thus leads to inquiry into ancient conditions of climate and topography. This is on the one hand; on the other we are led to human applications —native fisheries, past and present (incidentally, the authors stand for the evolutionary, as opposed to the diffusionist, theory of culture), and the introduction of European methods and their consequences, actual and prospective. In this respect "Inland Waters of Africa" furnishes an effective illustration of the interdependence of scientific knowledge.